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SYSTEMS CONSULTING AND ENGINEERING GAME OF INNOVATION: CHANGES TO THE PROJECT DEFINITION AND SCOPE

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SYSTEMS CONSULTING AND ENGINEERING GAME OF INNOVATION : CHANGES TO THE PROJECT DEFINITION AND SCOPE

présentée par : NEHMÉ Joseph

en vue de l'obtention du diplôme de : Philosophiae Doctor

a été dument acceptée par le jury d'examen constitué de :

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To Marie

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RÉSUMÉ

Cette étude s'intègre dans le programme de recherche MINE (Managing Innovation in the New Economy) qui a développé le concept de Joutes d'Innovation. Ce dernier rejette le modèle universel d'innovation qui s'adresse à toutes les compagnies et industries. Il considère qu'il y a différents modèles pour innover, basés sur différentes variables contextuelles. Le modèle de MINE a identifié sept Joutes d'Innovation qui sont résumées dans l'annexe A.

Cette recherche se concentre sur la Joute d'Innovation de System Consulting and Engineering (SEC), qui se caractérise par une haute dynamique de marché ainsi qu'une forte interdépendance entre plusieurs acteurs et partenaires. L'innovation dans cette joute se produit principalement sous forme de projets. Plusieurs partenaires doivent collaborer afin de réaliser un nouveau programme / projet lancé par un client commun. Les sociétés de conseil commercialise misent de plus en plus leur capacité d'innovation dans leurs offres de services. La gestion des projets innovateurs représente plusieurs défis pour les compagnies de conseils. Le succès des projets innovateurs est principalement mesuré en fonction de l'objectif et de l'envergure établis au préalable par le client. Il est difficile de déterminer la performance exacte d'un projet technologique innovateur malgré plusieurs projets pilotes. La littérature existante ne traite ni de l'évolution de l'envergure du projet ni de l'évolution de la définition du projet tout au long de la phase de réalisation. Certains chercheurs reconnaissent l'évolution de l'envergure du projet mais uniquement dans l'initiation de la phase de réalisation. Ceci nous a mené à concentrer notre recherche sur les changements qui surviennent durant la phase d'implantation d'un projet innovateur.

Cette recherche a pour objectif principal de comprendre comment la définition de projet, composée de cinq éléments (envergure, organisation, qualité, coût et temps), évolue tout

au long de la phase d'implantation d'une solution innovante et propriétaire. Les trois principales hypothèses de cette recherche se résument en ce qui suit :

H1 : Des changements à la définition du projet et à son envergure surviennent tout au long de la phase de réalisation d'un projet innovant.

H2 : La définition du projet et de son envergure sont modelés par des influences multiples exogènes au projet ainsi que par des incertitudes émergentes qui lui sont endogènes.

H3 : Les solutions hautement innovatrices sont modelées par des changements exogènes et endogènes alors que les solutions moyennement innovatrices sont principalement modelées par des changements endogènes.

Cette recherche a été réalisée en cinq étapes qui se sont succédées durant les 3 dernières années :

1) Une étude exploratoire afin de comprendre la dynamique de l'innovation dans la Joute SEC ainsi que les caractéristiques des différents joueurs. Au cours de cette phase, 12 gestionnaires séniors provenant de grandes entreprises de conseil en Europe ont été interviewés. Ceci a été complété par une recherche documentaire.

2) Une étude exploratoire afin de mieux comprendre les solutions technologiques ainsi que leur écosystème. Ceci nous a mené a rencontrer 23 gestionnaires et étudier 10 projets technologiques majeurs en Amérique du Nord.

3) Une étude qualitative de l'implantation de 5 grandes solutions technologiques propriétaires. Ces dernières sont entreprises par trois grandes institutions financières Canadiennes.

4) Une étude détaillée de plus de 500 demandes de changements rapportées dans le cadre de ces 5 grandes initiatives. Ceci dans le but de comprendre l'évolution de la définition du projet et de l'envergure tout au long de ces projets. Trois de ces projets ont été classés comme hautement innovateurs alors que les deux autres comme moyennement innovateurs.

5) Une étude exploratoire des approches mises en place par le client et les entreprises de conseils afin de gérer l'évolution de la définition du projet et de l'envergure. Cette dernière phase fut complétée par les entrevues de 21 gestionnaires séniors de 7 grandes entreprises de conseil Indiennes.

Une analyse détaillée de plus de 500 demandes de changement a été réalisée afin de supporter les hypothèses mentionnées ci-dessus. Chaque demande de changement a été analysée et classée selon le modèle conceptuel de cette recherche. Les variables indépendantes représentent les éléments exogènes et endogènes qui engendrent des demandes de changements. Alors que les variables dépendantes évoquent les cinq éléments de la définition de projet. Ceci nous a mené à de nouveaux constats qui se résument en ce qui suit :

1) Les changements qui génèrent un impact majeur sur la définition du projet sont principalement déclenchés par la catégorie des influences multiples exogènes au projet. Par contre, les changements qui génèrent un impact mineur sur la définition du projet sont générés par la catégorie des influences multiples exogènes ainsi que la catégorie des incertitudes émergentes endogènes au projet.

2) L'impact des changements sur la définition du projet est plus prononcé au début de la phase de réalisation. Il tend à diminuer avec le temps.

Par ailleurs nous avons observé 6 approches différentes adoptées par les clients et les sociétés SEC pour faire face à une définition de projet et envergure évolutives.

Les deux premières approches jouent un rôle dans l'initiation de la phase de réalisation avant la signature des contrats et sont :

1) Instauration d'un Écosystème composé de toutes les parties prenantes qui révisent et valident conjointement la définition du projet afin de réduire les mauvaises interprétations et éliminer les zones grises.

2) Adoption d'une approche optionnelle.

Deux autres approches ont été identifiées au cours de la phase de réalisation :

1) Constitution d'un comité d'architectes qui a pour rôle de veiller sur la portée et l'envergure du projet.

2) Instauration d'un calendrier global pour gérer les différentes phases de projets interdépendants afin d'éviter les conflits potentiels.

Les deux dernières approches sont plus globales :

1) Adoption d'une approche ou de la méthodologie Agile de développement et

2) différentes formes de partenariat stratégiques.

Finalement, cette étude nous mène à d'autres pistes de recherche pour mieux gérer et réussir des projets innovateurs. Basés sur le degré d'innovation d'une solution propriétaire, les gestionnaires cadres peuvent adopter plusieurs approches et configurer plusieurs paramètres afin de mieux réussir leurs initiatives. Parmi les paramètres à prendre en considération nous avons noté : la composition de l'équipe de projet, la structure du projet, le type de contrat, les approches de gestions, le partenariat etc.

ABSTRACT

This research falls within the global MINE program where the concept of Games of Innovation has been developed. The concept of Games of Innovation rejects the global prescription model of innovation that applies to all companies and industries. It stipulates that there are diverse patterns by which firms innovate. This is based on different contextual variables that determine the Game in which firms play in and compete.

This research focuses on the System Consulting and Engineering services Game of Innovation which is characterized by high market dynamics and strong interdependence among several partners and actors. Innovation in this Game happens through projects where multiple players cooperate to reach a common client's objective. Innovative projects are becoming part of all consulting firm's service offerings and managing large IT innovative projects is a challenging task for most managers. Success for most IT projects tends to be measured or determined based on the initial objective and initial scope. Literature hardly addresses dynamic project definition and evolving scope. Most literature acknowledges the time and schedule evolution. This doesn't address scope evolution which often drives the remaining project elements and requires a new baseline for the time and cost elements. Some literature addressed project definition and scope evolution only in the front end of the solution's implementation phase and not throughout the latter phase. This led us to focus our research on changes that occur all through the implementation of a solution.

Consequently, our research objective was to understanding how project definition which is composed of five main elements (scope, organization, quality, cost and time) evolves throughout the implementation lifecycle of a large proprietary innovative IT solution. The main hypotheses supported in this research are the following: H1: Changes to the

project definition and project scope occur all through the implementation lifecycle of an innovative project. H2: Project definition and scope are shaped by multiple influences exogenous to the project boundaries as well as by emergent uncertainties endogenous to the project boundaries. H3: Highly innovative solutions are triggered by both exogenous and endogenous changes while less innovative solutions are mainly triggered by endogenous changes

This research was conducted in five phases that spanned over 3 years. The approach is inspired by the grounded theory where theory is built from qualitative data then validated again through a field study. Below is a recapitulation of the main five phases of this research. The five phases are:

1) Exploratory research to understand the SEC dynamics and the player's characteristics. This covered interviews of 12 senior managers from seven top consulting firms in Europe,

2) Exploratory research to understand large IT solutions and their corresponding ecosystem. This covered interviews of 23 managers working on 10 IT projects in North America,

3) Qualitative analysis of five (5) large innovative proprietary IT projects undertaken by major financial institutions and generation of a conceptual model,

4) Detailed analysis of more than 500 change requests (CR) and the evolution of project definition and scope within the five previously mentioned projects (5) large innovative proprietary IT projects undertaken by major financial institutions. Three projects were selected as high innovative and two as medium to low innovative,

5) Exploration of the different solutions and approaches used by SCE firms and clients to address the project definition and scope evolutions. Twenty one (21) senior managers coming from seven (7) top Indian system integration firms were interviewed for a period of one to two hours each.

A detailed analysis of more than 500 CRs supported the above stated hypotheses. Each CR was analyzed in detail and mapped to the conceptual model. The independent variables represented the exogenous and endogenous elements that led to generating a CR while the dependent variables consisted of the five project definition elements. This also led to two new findings summarized in what follows: the first states that changes with high impact on the project definition mainly originate from the exogenous multiple influences group. While Changes with medium to low impact on the project definition come from both the exogenous multiple influences group and the endogenous emergent uncertainty group. Secondly, despite the fact that changes are logged all through the implementation phase we observed that the impact of the CRs on the project definition tends to decline with time. This assumes that projects are properly managed.

In addition we observed six main approaches used by clients and SECs to address and handle a dynamic project definition.

Two approaches on the Front-End which are: 1) the Validation phase where all stakeholders are gathered to review the project definition and all contracts before final commitment, 2) Real Options where small pilot projects are initiated and the commitment date is postponed until more information is available.

Two other approaches were found in the project unfolding which are: 1) scope management and control, 2) global calendar to manage concurrent projects.

Finally two global approaches were also found which are: 1) agile strategy which consists of adopting an agile methodology on the development level or even on the enterprise level and 2) selective partnership with one or multiple SI. Different partnership models are also explained.

Finally, this research can be considered a base for future work. Based on the degree of innovation of a particular project, senior management can take several actions and decisions to ensure the best conditions in order to succeed and meet the established objectives. Several configurations of different parameters can be composed for every project depending on its innovation degree and contextual variables. Some of the parameters that can be taken into account are the following: project management team composition, project structure, contract type, methodology type, management approaches, partnership and others.

More research can explore the most suitable configuration of the above parameters with regards to the innovation degree as well as the exogenous/endogenous environment of a particular project. This can develop a guideline for managers planning to undergo an innovative project.

CONDENSÉ FRANÇAIS

Cette recherche fait partie du programme de recherche MINE (Managing Innovation in the New Economy) qui a développé le concept de Joutes d'Innovation. Ce dernier rejette l'approche qui prescrit un model universel d'innovation qui s'applique à toutes les compagnies et industries. Il stipule qu'il y a divers modèles utilisés par les firmes pour innover selon la joute dans laquelle ils se trouvent. Sept joutes d'innovations ont été identifiées. Elles sont résumées dans l'Appendice A.

Cette recherche se concentre sur la joute de 'System Consulting and Engineering services' (SCE) qui se caractérise par une haute dynamique de marché et une forte interdépendance entre plusieurs acteurs et partenaires. Un client expert contracte plusieurs firmes de conseils et d'intégration de systèmes afin d'implanter une solution intégrée innovatrice ou une migration technologique majeure. Ceci entraine le client dans un partenariat à long terme, avec plusieurs firmes, qui s'étend au-delà du cycle de vie de l'implantation.

Les observations suivantes ont été soulevées suite à une révision de la littérature et d'une étude exploratoire de la joute SCE:

1. le succès de la majorité des projets TI est mesuré en fonction de l'objectif et l'envergure initiaux établis par le client.
2. Il est difficile de déterminer la performance exacte d'un projet technologique innovateur malgré plusieurs projets pilotes.
3. L'implantation de systèmes intégrés majeurs requiert la collaboration d'un client avec plusieurs partenaires spécialisés.
4. La littérature existante ne traite ni l'évolution de l'envergure du projet ni l'évolution de la définition du projet tout au long de la phase de réalisation.

5. Certains chercheurs ont pris en compte une évolution de l'envergure du projet mais uniquement dans l'initiation de la phase de réalisation. Ceci a principalement été mentionné dans la littérature de l'approche optionnelle, les littératures d'analyse de risques et celle contractuelle.

Cette recherche a été menée selon cinq étapes qui sont résumées dans ce qui suit :

Étape 1 : Joute SCE.

Le but de cette première étape est d'explorer et de comprendre la dynamique d'innovation dans la Joute SCE ainsi que les caractéristiques et rôles des différents joueurs qui en font partie. Une série d'étude de cas a été réalisée principalement en Europe auprès de grandes compagnies faisant partie de la Joute. Douze (12) gestionnaires séniors appartenant à sept (7) des grandes firmes de conseil et d'intégration de systèmes ont été interviewés pendant une période de 1 à 2 heures chacun. Ceci a été accompagné d'une recherche documentaire détaillée.

Quatre types de joueurs ont été identifiés dans cette joute en plus du client : 1) le stratège, 2) l'architecte, 3) le gestionnaire de projet et 4) l'opérateur. Ceci est résumé dans la Figure 1.

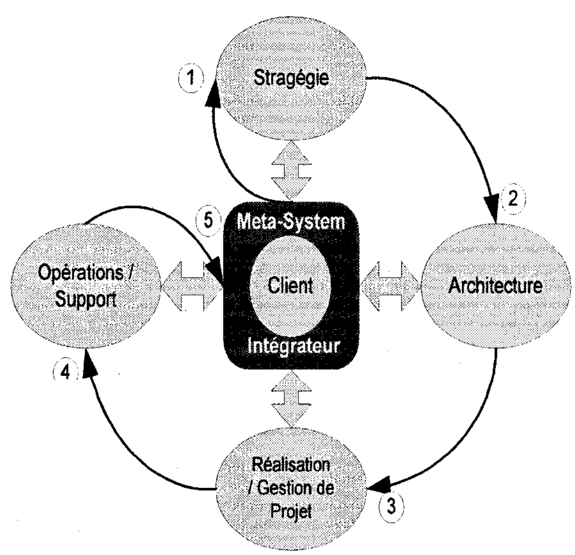

Figure 1: Différents joueurs de la joute SCE

Le facteur de collaboration a été étudié en fonction des quatre types de joueurs impliqués dans cette Joute. Ce facteur joue un rôle important dans un écosystème ou tous les joueurs sont interdépendants. Ceci est résumé dans la Figure 2 qui a été inspirée de Davenport (2005) et complétée dans cette phase.

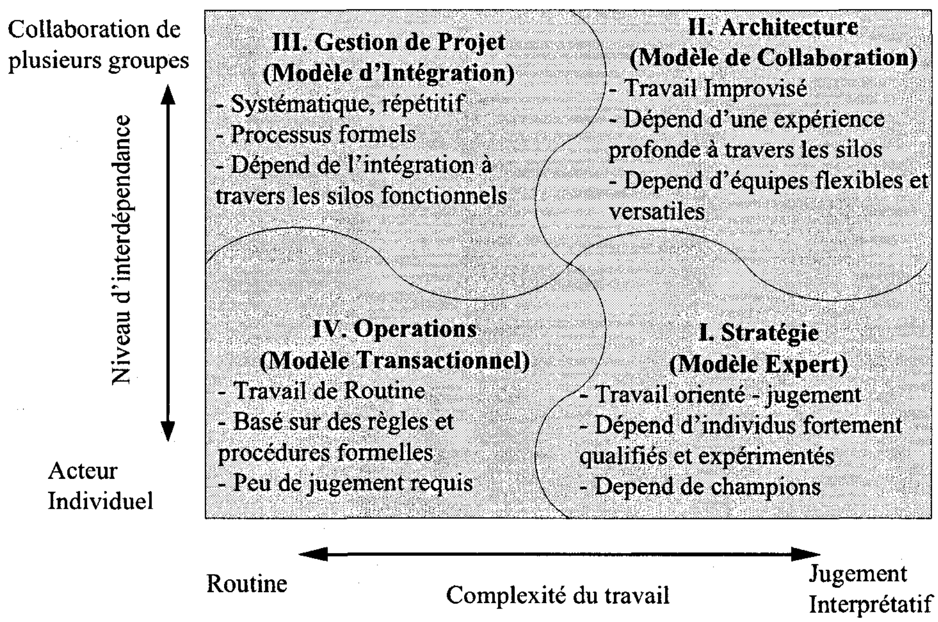

Figure 2 : Rôle de la collaboration pour les joueurs de la SCE

Ainsi, nous comprenons que l'innovation dans cette Joute se produit principalement sous forme de projets. Plusieurs partenaires, qui sont concurrents au niveau de l'industrie, doivent collaborer au niveau d'un programme/projet initié par un client commun. Ceci nous a amené à la prochaine étape où nous avons étudié les solutions intégrées.

Étape 2 : Solutions Intégrées.

Dans cette deuxième étape nous nous sommes concentrés sur l'étude de projets TI majeurs initiés par de grands clients. Ces projets impliquaient une multitude de partenaires qui comprenaient des intégrateurs de systèmes, des fournisseurs de logiciel et de hardware, différentes unités d'affaires, des régulateurs etc. Tous ces partenaires devaient collaborer afin de réussir le projet. Dix programmes/projets d'implantation de nouvelles solutions intégrées ont été étudiés. Un total de 23 entretiens avec des gestionnaires séniors qui étaient impliqués dans ces projets ont été réalisés. Chaque étude de cas a été complétée par une recherche documentaire détaillée.

Deux types de systèmes ou solutions ont été identifiés : 1) Solutions intégrées matures tel que les Enterprise Resource Planning (ERP) et les Material Resource Planning (MRP) et 2) Solutions intégrées jeunes tel que les Product Life-Cycle Management (PLM). La dynamique et le degré d'innovation sont différents dans ces deux systèmes. L'implantation de solutions matures, déjà opérationnelles dans la majorité des industries et chez un grand nombre de clients est la moins innovatrice. Ces systèmes ont déjà développé la majorité de leurs modules et leurs fonctions et les processus d'implantation sont très bien connus, alors que l'implantation de systèmes jeunes est plus innovatrice. Ces systèmes développent toujours de nouveaux modules majeurs et ne sont pas encore présents dans toutes les industries. L'implantation du PLM Catia dans une firme hydro électrique tel qu'Hydro Québec est une première mondiale. Un troisième classement de solutions intégrées a aussi été identifié. Ce sont les solutions intégrées propriétaires développées par un grand client. Ces solutions comprennent le plus grand degré d'innovation et seront le sujet d'étude de la troisième Étape.

3ième Étape : Solutions Intégrées Propriétaires.

Dans cette troisième étape, le travail de recherche fut concentré sur l'étude d'implantation de solutions intégrées et de systèmes propriétaires innovateurs chez un client majeur. Ce groupe de solutions et systèmes est le plus exigeant. Ces systèmes sont uniques à un seul client. L'équipe de projet peut difficilement capitaliser sur des implantations similaires réalisées chez le client même ou ailleurs. Cinq projets ou systèmes implantés dans trois grandes institutions financières canadiennes ont été choisis. Trois de ces projets ont été classés par l'institution en question comme hautement innovateurs alors que les deux autres ont reçu la classification de moyennement innovateurs. Les projets étudiés sont les suivants :

1. Internet Infrastructure Revamp (IIR) : motivé par des besoins technologiques et d'affaires - hautement innovateur,
2. Check Imaging (CI) : motivé par une réglementaire – hautement innovateur,
3. Basel Accord II (BIIA) : motivé par une réglementaire – hautement innovateur,
4. Intranet Infrastructure Migration (IIM) : motivé par des besoins technologiques et d'affaires – moyennement innovateur,
5. Application Revamp : motivé par des besoins d'affaires et technologiques – moyennement innovateur.

Cette étape nous a permis d'observer que la définition du projet et l'envergure évoluent durant la phase d'implantation de la solution. La majorité de la littérature reconnait et explique l'évolution des éléments de temps et de cout de la définition de projet. Ceci ne Traite ni l'évolution de l'envergure ni celle de la portée. Cette dernière est l'élément principal de la définition du projet qui entraine une évolution des autres éléments, notamment le temps et le coût.

<u>Objectif de la recherche et modèle conceptuel.</u>

L'objectif principal de cette recherche est de comprendre comment la définition de projet, composée de cinq éléments (envergure, organisation, qualité, cout et temps) évolue tout au long de la phase d'implantation d'une solution innovatrice et propriétaire. Une attention particulière est protée sur l'envergure qui est l'élément principal et qui affecte souvent les éléments secondaires.

Cette troisième étape nous a permis de développer le modèle conceptuel de cette recherche. Ceci est présenté dans les Figure 3 et Figure 4. Il est à noter que ce modèle a évolué tout au long de l'étape 4.

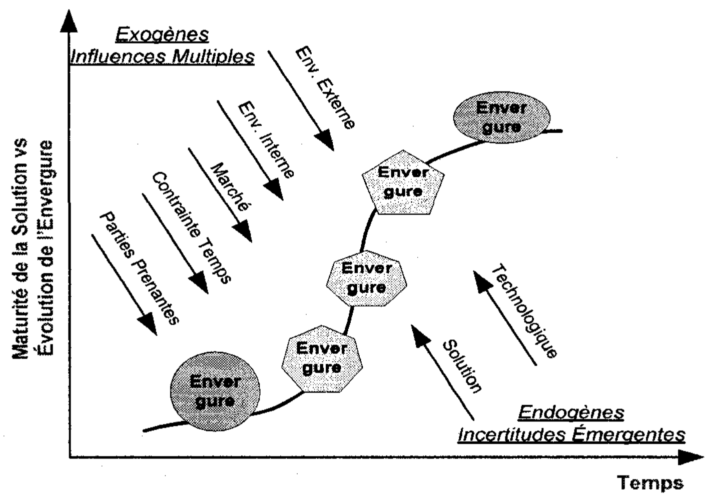

Figure 3: Évolution de l'envergure d'une solution innovatrice

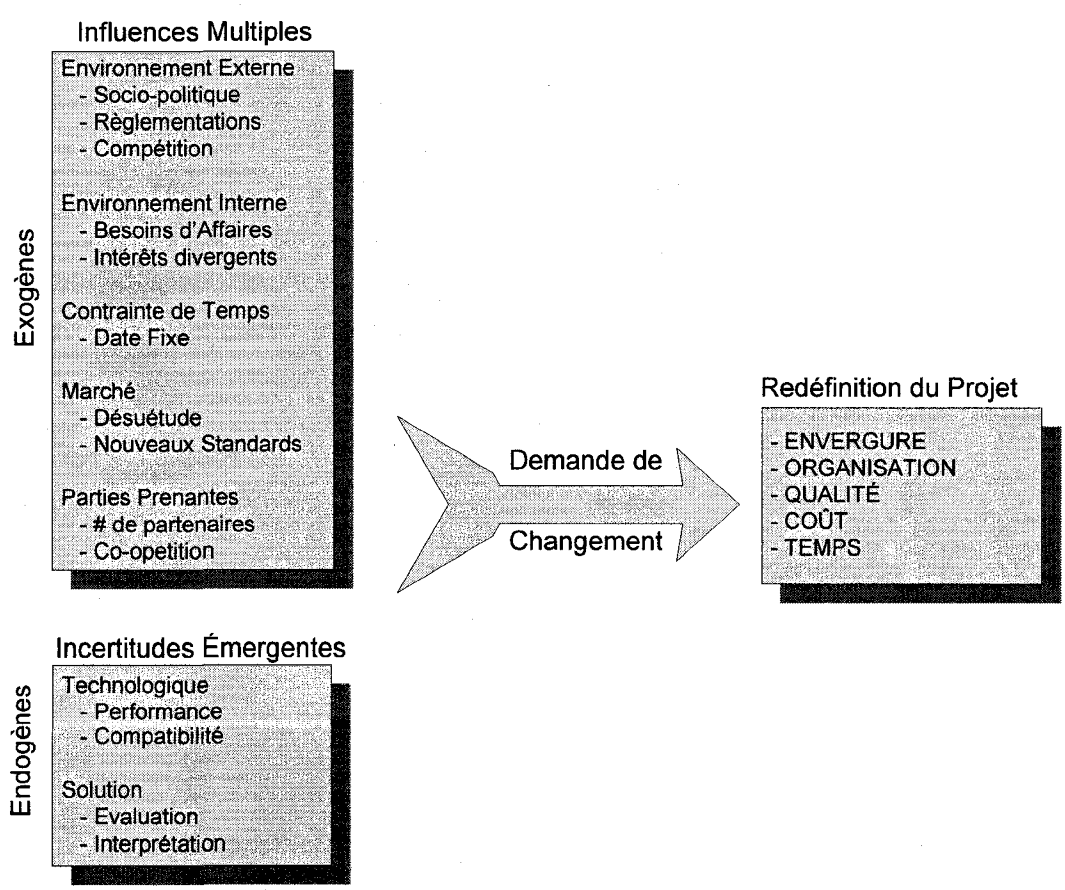

Figure 4 : Modèle conceptuel

Les principales hypothèses de cette recherche se résument en ce qui suit :

H1 : Des changements à la définition du projet et de son envergure surviennent tout au long de la phase de réalisation d'un projet innovateur.

H2 : La définition du projet et de son envergure sont modelés par des influences multiples exogènes au projet ainsi que par des incertitudes émergentes qui lui sont endogènes.

H3 : Les solutions hautement innovatrices sont modelées par des changements exogènes et endogènes alors que les solutions moyennement innovatrices sont principalement modelées par des changements endogènes.

La prochaine étape consiste à faire une étude approfondie de l'évolution de la définition du projet de ces 5 projets afin de valider ces trois hypothèses.

4ième Étape : Analyse détaillée des changements.

Cette quatrième étape a couvert : 1) une analyse approfondie de chacun de cinq systèmes propriétaires mentionnés ci-haut et 2) une analyse détaillée de plus de 500 changements qui ont été rapportés tout au long de la phase de réalisation de chacun de ces systèmes. Ces changements ont eu un impact direct sur un ou plusieurs éléments de la définition du projet.

Une étude documentaire détaillée des 500 changements ainsi que des contrats, documents d'architecture, résumés des rencontres de gestion et ateliers etc. a été effectuée afin de bien comprendre l'évolution de la définition du projet dans chacun des 5 projets.

Le modèle conceptuel présenté à l'étape trois a évolué tout au long de l'étape 4 et du codage des 500 changements. Cinq itérations ont été nécessaires pour arriver à un modèle représentatif de tous ces changements. A chaque itération une revisite de tous les changements était nécessaire afin de s'assurer de la fiabilité du modèle.

Tableau 1 : Nombre de changements par élément du modèle conceptuel

		Hautement Innovateurs			Moyennement Innovateurs	
		IIR	CI	BIIA	IIM	AR
Exogènes - Influences Multipes	**Environnement Externe**					
	Socio-Politique	5	0	0	0	0
	Règlementation	0	25	0	0	0
	Compétition	4	10	3	0	0
	Environnement Interne					
	Besoins d'Affaires	39	44	57	0	2
	Interrets Divergents	29	16	38	3	0
	Contrainte de Temps					
	Date Fixe	11	2	5	0	0
	Marché					
	Désuétude	31	0	1	2	1
	Nouveaux Standards	1	24	0	0	0
	Parties Prenantes					
	# de partenaires	21	12	31	0	2
	Co-opetition	20	1	5	0	0
Endogènes - Incertitudes Émergentes	**Technologie**					
	Performance	51	47	7	6	8
	Compatibilité	57	52	4	1	2
	Solution					
	Evaluation	22	0	24	14	7
	Interprétation	37	124	50	5	11

Le Tableau 1 résume et classe tous les changements étudiés en fonction du modèle conceptuel. L'analyse de tous ces changements nous a permis de supporter les hypothèses mentionnées ci-dessus. De plus nous sommes arrivés à deux autres conclusions résumées ci-après :

- Les changements qui génèrent un impact majeur sur la définition du projet sont principalement déclenchés par la catégorie des influences multiples exogènes au projet. Alors que les changements qui génèrent un impact mineur sur la définition du projet sont générés par la catégorie des influences multiples exogènes ainsi que la catégorie des incertitudes émergentes endogènes au projet.

- Nous avons mentionné dans la première hypothèse que les changements qui impactent la définition du projet surviennent tout au long de la phase de réalisation. Toutefois nous avons remarqué que l'impact de ces changements est plus prononcé au début de la phase de réalisation et tend à diminuer avec le temps.

Aussi, cette recherche nous a amené à nous intéresser aux approches utilisées par les clients et les firmes d'intégration de systèmes pour faire face à une définition de projet dynamique et évolutive. Ceci est complété dans la cinquième étape.

5^{ième} Étape : Approches pour faire face à une définition de projet évolutive.
Le but de cette dernière étape était d'étudier comment les clients et les firmes de conseils et d'intégration de systèmes font face à l'évolution de la définition du projet tout au long de la phase de réalisation. Pour répondre à cette question nous avons 1) revisité les cinq systèmes propriétaires mentionnés ci-dessus et 2) effectué une série d'études de cas auprès de sept (7) compagnies d'intégration de systèmes situées en Inde. Ces compagnies desservent entre autres de grandes institutions financières nord-américaines et européennes. Vingt et un gestionnaires exécutifs ont été interviewés pendant une période de 1 à 2 heures chacun. Ceci nous a mené à six approches utilisées par des clients et intégrateurs de systèmes pour faire face à une définition de projet dynamique. Ces approches ont été groupées en trois catégories, élaborées ci-dessous :

1) Pré-initiation du projet qui comprend deux approches :

- Écosystème composé de toutes les parties prenantes qui révisent et valident conjointement la définition du projet afin de réduire les mauvaises interprétations et éliminer les zones grises. Les contrats seront aussi révisés en conséquence. Ceci doit être complété avant le lancement du projet.

- Approche Optionnelle. Dans ce cas le client lance de petites initiatives ou projets pilotes afin d'avoir plus d'information sur les différentes options disponibles. Ceci génère des données supplémentaires qui aideront le client à prendre une décision plus éclairée avant de se commettre à une solution particulière.

2) Durant la réalisation du projet qui consiste en deux approches :

- Comité de gestion de l'envergure : les gestionnaires de projet instaurent un comité formé d'architectes provenant de tous les partenaires qui aura la responsabilité de veiller sur la portée et l'envergure du projet. Les recommandations de ce comité sont transmises aux gestionnaires pour prendre les décisions appropriées.

- Calendrier Global : dans le contexte de solutions intégrées qui s'implantent sur l'infrastructure globale, plusieurs projets menés par différentes unités d'affaires deviennent interdépendants. Ceci requiert un calendrier global pour gérer les différentes phases des projets interdépendants afin d'éviter les conflits au niveau des environnements.

3) Approches globales.

- Stratégie Agile : Ceci consiste à adopter une méthodologie de développement agile qui s'adapte à un contexte dynamique et qui prend en compte une définition évolutive du projet.

- Partenariat : cette dernière approche consiste à établir un partenariat de longue durée entre un client et une firme d'intégration de systèmes. Différents types de sous-traitance et partenariat peuvent être envisageables.

Applications

Finalement, tout au long de cette recherche nous avons supporté le fait que la définition des projets innovateurs est modelée tout au long de la phase de réalisation par des éléments exogènes et endogènes. Ceci génère une dynamique de projet ou la gestion traditionnelle telle que celle rationnelle et celle adaptative ne sont pas adéquatent.

Basé sur le degré d'innovation d'un projet, les gestionnaires peuvent prendre une série de mesures pour assurer les meilleures conditions possibles pour réussir ce projet. Plusieurs configurations d'une série de paramètres peuvent être définies en fonction du degré d'innovation du projet et de ses variables contextuelles. Quelques uns des paramètres retenus sont : 1) composition de l'équipe de projet et caractéristiques des ressources, 2) Structure de projet, 3) type de contrat, 4) méthodologie, 5) Approche pour gérer l'envergure, 6) Partenariat, 7) autres paramètres.

Une étude approfondie de la meilleure configuration de ces paramètres en fonction du degré d'innovation du projet et de ses variables contextuelles est à réaliser. Ceci amènera un guide qui aidera un client de choisir la meilleure configuration de ces paramètres afin de réaliser un projet innovateur.

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LIST OF ABBREVIATIONS

ARC	Architecture Routine Culture
ATM	Automated Teller Machine
BI	Business Intelligence
BOM	Bill of Material
BPR	Business Process Reengineering
BU	Business Unit
CMM	Capability Maturity Model
CPA	Canadian Payments Associations
CPI	Cost Performance Index
CR	Change Request
CRM	Customer Relationship Management
CSF	Critical Success Factors
DMS	Distribution Management System
DS	Dassault Système
DST	Daylight Saving Time
EAS	Enterprise Application Suite
ERP	Enterprise Resource Planning
FTP	File Transfer Protocol
GORO	Growth Opportunities Real Options
GUI	Graphical User Interface
HQ	Hydro Quebec
HR	Human Resource
IIR	Internet Infrastructure Revamp
IS	Information System
ISO	International Standard Organization
ISS	Information Sub System

IT	Information Technology
MICR	Magnetic Ink Characters Recognition
MINE	Managing Innovation in the New Economy
MIS	Management Information Systems
MRP	Material Resource Planning
MRP II	Manufacturing Resource Planning
NPV	Net Present Value
OCR	Optical Character Recognition
PARC	Palo Alto Research Center
PC	Personal Computer
PLM	Product Lifecycle Management
PM	Project Manager
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PORO	Process Optimization Real Options
RSP	Retirement Savings Plan
SARS	Severe Acute Respiratory Syndrome
SBU	Strategic Business Unit
SCM	Supply Chain Management
SCE	System Consulting and Engineering
SFTP	Secured File Transfer Protocol
SI	System Integrator
SPI	Schedule Performance Index
SQL	Structured Query Language
SVP	Senior Vice President
TECP	Truncation and Electronic Check Presentment
TDWI	The Data Warehouse Institute
TQM	Total Quality Management
VCR	Video Cassette Recording

WAS	Web sphere Application Server
WBS	Work Breakdown Structure
WMS	Warehouse Management System

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.I. Innovation

In today's economy, innovation is viewed as a source of sustainable competitive advantage. It is important to differentiate between "invention" and "innovation". Invention is when the thought of a new product or process is first conceived, whereas innovation is when this idea is commercialized into a product. Buxton (2005) considers that "innovation is far more about prospecting, mining, refining and adding value than it is about pure invention". In other words, the innovation process can be viewed as the transformation of knowledge into working artefacts: products, systems, processes and services (Pavitt, 2005). To transform an invention into an innovation a firm normally needs to combine several different types of knowledge, capabilities, skills and resources (Fagerberg, 2005:5).

Innovation has been traditionally considered a random and an unmanageable process of creative thinking. Schumpeter (1934), in his early works, argued against this misconception and "distinguished between five different types of innovation: 1) new products, 2) new methods of production, 3) new sources of supply, 4) exploitation of new markets and 5) new ways to organize business." (Fagerberg, 2005:6)

Schumpeter also categorized innovation as incremental vs radical or marginal. An incremental innovation is considered to be an improvement along a technological path which has low uncertainty about the income. Radical innovation, on the other hand, occurs when a major change in technology diverges from its previous technological path.

Christensen (1997) stresses yet two other categories of innovation, sustaining and disruptive, which he considers different from the radical and incremental classification.

"Sustaining technologies refer to the successive incremental improvements to performance that market incumbents incorporate into their existing products." These improvements sustain the incumbents' core competencies and capabilities. Hence a sustaining technological innovation could be incremental or radical. Disruptive technologies, conversely, "often emerge from lower performance or less expensive products or processes that gain a foothold in the low end part of an existing market only to move up through performance improvements until they eventually replace the incumbents" (Christensen and Raynor, 2003). Hence disruptive innovation can be viewed as an architectural innovation designed for new applications that target a new or a different market segment.

In the beginning of the industrial era, innovation took place in small shops or what is more commonly known as a "garage". It was usually led by an entrepreneur who had limited resources. Later, firms such as IBM and Xerox, started internal R&D and research facilities to develop new technologies and products. The Palo Alto Research Center (PARC) of Xerox was funded for more than thirty years and was behind many innovations such as the graphical user interface (GUI), bit-mapped screen, Ethernet networking protocol, PostScript and many others (Chesbrough, 2003a:3). Companies adopted a closed innovation approach where they generated their own ideas, developed, built, marketed, distributed, serviced, financed and supported them on their own (Chesbrough, 2003a). The closed innovation dominated most of the latter half of the twentieth century.

However, ever-increasing knowledge bases as well as a growing complexity of the production of scientific and technological knowledge drove firms to use a variety of internal and external networks for a successful innovation process (Pavitt, 2005, Powel and Grodal, 2005). The economy was characterized by the rise of the knowledge worker as well as the expert client (Davenport, 2005). This lead to the open innovation paradigm, where firms developed new business models that combined internal and external ideas to create value for a product, service, solution etc. Furthermore open innovation permitted internal ideas to be routed to the market through external networks and therefore generate more value (Pavitt, 2005, Powel and Grodal, 2005, Chesbrough, 2003b). The networks could be 1) informal based on shared community, 2) project related, 3) regional where spatial proximity helps maintain a common community and 4) business related such as strategic alliances among two or more parties (Powel and Grodal, 2005:60).

While several models were developed for the different types of innovation that are mentioned above, neither could be accepted as universal nor could be applied across all industries. Each of the existing models pretends to have a unique recipe and a mix of ingredients that must be respected to be innovative. However different industries or firms have different contextual variables. It is imperative to take into consideration the heterogeneous contextual variables of each industry or firm.

1.II. Games of Innovation

Lately, some researchers reported that the innovation process is heterogeneous and differs from one sector to another (Pavitt, 1984, Pavitt, 2005). Differences have also been noticed based on the type of technology management systems (Best, 2003).
This research is part of the MINE (Managing Innovation in the New Economy) program. The MINE program developed the concept of 'Games of Innovation' which rejects the universal prescription of innovation that applies to all firms and industries. The concept of Games of Innovation stipulates that there exists different patterns by which firms innovate. This depends on different contextual variables that determine the Game in which firms play in and compete. Miller and Olleros (2006) define Games of Innovation as "Stable logics and rules of innovation, involving sets of interdependent complementary players and generating dynamics but persistent patterns in the creation

and capture of value over time." Different Games are characterized by different contextual conditions.

Seven Games were identified based on the solution's evolution process and the system's architectural conditions as seen in appendix A.

The central thesis of Games of Innovation is that successful firms are those that adapt their strategies, capabilities and practices to the innovation requirements of the Game(s) they chose to play in or compete.

The following seven games were identified as shown in appendix A:

1) **Patent driven discovery**; i.e. are medications and batteries,

2) **System Integration**, i.e. Drug-design softwares, electronic design-automation tools, design–engineering systems, PLM etc

3) **Plateform Orchestration**, i.e. telecommunication, PC, PDA devices,

4) **Cost-Based Competition**; *i.e. Aluminum producers,*

5) System Consulting and Engineering (SCE) services, *i.e. Information Systems,*

6) Customizing and mass production, *i.e. VCR, automobile etc.*

7) **Supporting Innovating Firms,** i.e. Forrester Research, Gartner.

This research studies the SCE services Game which is located on the intersection of tightly integrated products and the market evolution as seen in appendix A. The SCE Game is characterized by high market dynamics and strong interdependence among several actors/partners. An expert client undergoes a major project such as the implementation of a large Integrated System or a major revamp of a technological infrastructure. Such projects could be the result of a new regulation or an aging and obsolete technological infrastructure, tools or solutions. These large projects usually stretch over several years before the idea is transformed into a working solution. Consequently, clients engage in a long term relationship with consulting firms and solution providers which spans beyond the project closure. Some client firms engage in outsourcing agreements where the relationships become even stronger. Different types of consultants play different roles depending on the episode of the solution life cycle.

The consulting profession is one of the fastest growing professions of the new economy. Consultants are hired to perform numerous and varied tasks. On the one hand, this covers managerial and organizational matters and on the other hand it deals with technological issues.

1.III. Problematic

Most industries and firms are betting on innovation to face the challenges of the new economy. In the past five years the Chief Innovation Officer position has been created in some major companies such as Xerox and Citigroup[1]. IBM is offering 'On demand Innovation' services to its clients[2]. Innovation is happening through projects where multiple players cooperate to reach a common objective. Innovative projects are becoming part of all consulting firm's service offerings and managing large IT innovative projects is a challenging task for most managers. Challenges are of different types as seen below.

Success for most innovative IT projects tends to be measured or determined based on the initial project definition and initial scope (Shenhar et al., 2001). Large innovative IT projects can span over a long period of time which lasts for several years. During this time, several external and/or internal environmental events take place which lead to changes in project assumptions and scope. On the one hand, external events such as new regulations or security acts can have a direct impact on a specific IT project. This will require changes to some modules or functions or even technical architecture that will shape the project's initial design and objectives. On the other hand, internal events can be related to new business needs that are continuously changing to adapt to the dynamic and competitive business environment.

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[1] http://www.businessinnovationinsider.com/2006/01/chief_innovation_officer_1.php

[2] http://domino.research.ibm.com/odis/odis.nsf/pages/index.html which is a partnership between IBM research and IBM Global Business Services

Large IT innovative projects coexist and share common resources along with operational and evolutionary projects. Banks, financial services, power plants, manufacturing firms etc. have to maintain and incrementally update an operational system while undertaking major changes to the system itself. Several projects and support teams can be running in parallel and working simultaneously to bring changes to one particular module. A project team's focus is on implementing major changes to the IT system while a project support team's concern is to provide online and continuous support for customers and incrementally upgrade the system. This requires total and challenging collaboration among different teams working on one particular system.

Large innovative IT projects require a client to work and collaborate with large specialized partners. Each partner brings his own organizational structure, routines, processes, tools and knowledge (Teece and Pisano, 1994). A typical integrated solution's lifecycle, which can span over several years, is characterized by four episodes namely strategy, architecture, implementation and operations, which can overlap. Different types of consultants and capabilities are required for each episode. This creates a challenge in managing the alliance among several competing and complementary firms and having them aligned toward one common objective. The knowledge economy is growing and evolving at a rapid rate and it is hard for one client whose main business is not IT to keep up with this fast pace. An example of such a client is a financial institution that cannot develop on its own and maintain all common and specialized IT systems and solutions required to run its business. Thus clients hire different types of consultants to tackle technological issues and project risks. Large IT projects involve consultants coming from different organizations that have different logics in interpreting and solving client problems. Having all these partners work together is a challenge to succeed in innovative IT solutions.

It is hard to predict the exact performance of an innovative IT system or infrastructure despite pilot projects (Miller et al., 1995). Technological uncertainties go along with innovative IT systems and solutions. Examples of uncertainties are software compatibilities, system performance and robustness. In addition, by the time a large system is built and implemented, a new technological cycle will start that will bring new software versions and new hardware components. Market uncertainties shape projects along their lifecycles.

Literature provides two main approaches to the above mentioned challenges. The first deals with the process while the second tackles the deliverable or the solution itself.

Most of the research and literature that treats IT system implementation adopts a linear or cascade approach to project management. The project management literature identifies different successive phases of a solution's lifecycle. For example the architectural phase has to be completed before the implementation phase starts. The implementation phase follows the architectural documentation. During the implementation phase the solution's design and architectural documentation are hardly questioned. Adopting a linear approach to project management might be possible when implementing a mature system with constant environmental variables and mature technology. A mature system is an integrated system such as an ERP which has been implemented in several industries and on several occasions. The system architecture and modules are stable. The implementation procedure is well known and tested. In the case of a proprietary or a custom system developed by a large client, the project management linear approach to system implementation cannot guarantee success. Proprietary systems are unique to one client. The system is developed for and used by one client. The system architecture is continuously evolving to cope with a dynamic and highly competitive environment. The project definition and scope when subject to multiple elements evolve throughout the solution's implementation lifecycle. New regulations, technological standards and business needs can emerge at any point in time and question the architecture and solution's scope.

The second literature approach focuses on the deliverable and final solution. Many researchers studied and provided a list of factors that contribute to the success of an innovative IT solution. Although these factors are important to take into consideration, they don't take into account the dynamic and evolving nature of the five elements of a project definition which are: scope, organization, quality, cost and time. Literature tends to focus only on the variations in the Time and Cost elements of the project definition. Researchers don't address the other main elements such as Scope and Organization variations along the solution's implementation lifecycle of innovative projects. Scope and Organization often drive changes to the Time and Cost elements.

1.IV. Research Objective

This research will first explore the different types of consultants that partake in a new solution from the birth of an idea to its implementation and operation. The characteristics and particularities of each group or type of consultants will be explored as well as the role they each play in every episode of the solution lifecycle. Moreover, the relationship among the different stakeholders will be examined as well as the different managerial levels that are involved in each episode.

More importantly, this research will focus and study the evolution of the project definition and scope along innovative projects undertaken within the SCE Game. This will be explained in terms of the elements that contribute to scope and project definition changes throughout the implementation of an innovative solution and their impact on the project definition.

In other words, the main objective of this research is to understand how project definition, which is composed of five elements (scope, organization, quality, cost and time), evolves throughout the implementation of a large innovative strategic proprietary complex IT solution. A particular stress is put on the scope element which has rarely been studied in the past. Scope is the main element of a project definition and often drives the remaining secondary elements (Turner, 1993).

1.V. Research phases and structure

A grounded research approach is adopted in our methodology. Theory is built from exploratory and qualitative data and then validated again through a field study. The unfolding of this research can be traced to five main phases that helped understand the SCE Game, generate the conceptual model and hypothesis, validate the latter against five (5) proprietary projects and explore new approaches used in the industry to deal with the above mentioned challenges. This is summarized in the following:

Phase 1:

This phase consists of an exploratory research to understand the dynamics of the SCE Game. This includes the different players' or system integrators' characteristics that partake in the phases of a solution's lifecycle. Twelve (12) senior managers from seven (7) top consulting firms in Europe and Middle East were interviewed for a period of 1 to 2 hours each. The results of this phase are presented in Chapter_2_I. The latter introduces the main strategy paradigms and relates them to the system integration concept. Four main types and roles of system integrators are then differentiated and mapped to the solution lifecycle episodes. This covers 1) the strategy role, 2) the architectural role, 3) the project management role and 4) the operational role. System integrators are usually external consultants hired by a client for a specific project. Chapter_2_I presents the result of the first exploratory phase of this research which aims at understanding the characteristics and roles of the players of the SCE Game. Finally, this first phase led us to understand that innovation in the SCE game happens through large projects where multiple partners and system integrators or consultants are contracted by one client to implement a large innovative solution. This led us to the second phase where we focus on the implementation of large innovative solutions.

Phase 2:

The second phase consists of an exploratory research to understand mission critical IT solutions and their corresponding ecosystems. Ten (10) IT related projects, from five different industries, were studied in North America. A total of twenty three (23) senior managers were interviewed for a period of one to two hours each in addition to a large documentation that was reviewed and analyzed.

This second phase led us to two main findings which are presented in Chapter_2_II. First, we identified different types of management information systems found in the market. Three main categories are distinguished: (1) mature systems which have been in the market for some time (2) growing systems which are still expanding into new industries and developing new modules and (3) proprietary systems which are custom systems developed for a particular large client. Chapter_2_II also traces the evolution of integrated systems. This will cover the architectural and infrastructural evolution. Second we noticed that change to project definition and scope is part of all three systems categories. Furthermore, we observed that proprietary systems which are associated with the highest degree of innovation because of their uniqueness are also subject to the most dynamic project definition along their solution's implementation lifecycle.

This second phase is followed by a review of three main literature streams that address integrated solutions implementations. This is covered in Chapter 2_III, IV and V and is summarized below.

Chapter_2_III reviews critical success factors for implementing an integrated information system. Three main views are studied: 1) IT focused view pioneered by Delone and Mclean (1992a, , 2003), 2) the environmental view (Ives et al., 1980) and 3) the ensemble view (Orlikowski and Iacono, 2001). A table summarizing the most common success factors found in the literature as well as the authors who studied these factors is presented at the end of this section. Although most of these views are valid, they don't account for the evolution of the project definition elements throughout the solution's lifecycle.

Chapter 2_IV reviews and explains the project definition elements. This will cover 1) scope, 2) organization, 3) quality, 4) time and 5) cost (Turner, 1993). Each element will be explained in detail and several illustrative examples will be provided. In addition, the most frequent success indicators found in literature will be summarized. Most firms tend to use the Time and Cost elements of the project definition as the main indicators of their project success. They don't take into account the scope evolution which is often responsible for changes to the Time and Cost baselines.

Chapter_2_V addresses the different types of risks and risk responses that face the solution throughout its lifecycle. This will be followed by an elaboration of the different contractual agreements that can be used to manage risks based on the client expertise and the uncertainties that face the solution. Then the real option's approach is introduced. This can be used in the context of innovative projects and project portfolios to postpone a management decision and capitalize on additional information and time. The real option's approach acknowledges changes to the project definition but this is only limited to the front end phase.

Finally, we notice that literature hardly addresses the evolution of the project definition and scope changes throughout the implementation lifecycle of major innovative solutions. Thus we decided to focus our research on studying the changes to the project definition and the scope evolution across the implementation of large innovative proprietary solutions.

Phase 3:

The third phase accounts for a qualitative analysis of five (5) large innovative proprietary projects undertaken by three major Canadian financial institutions. Three projects are highly innovative while the other two projects are flagged by the financial institutions as medium to low innovative. This phase contributed to generating the conceptual model of this research. Chapter_3 presents the methodology used for this research. The latter is inspired from the grounded theory where theory is built from qualitative data then validated again through a field study. The five main phases of this research are explained in this chapter. In addition, the research conceptual model, objectives and hypothesis are introduced and explained. All elements and variables of the conceptual model are also detailed and explained. Finally, the unit of analysis of this research which is 'Change Request' is also presented. It will be detailed in chapter_4_I.

Phase 4:

The fourth phase presents a detailed analysis of more than five hundred (500) Change Requests issued for the five proprietary projects. This analysis studies the evolution of project definition and scope within innovative strategic complex proprietary IT projects and the elements that contribute to these changes. This phase also explores some approaches used by these five projects to deal with change and dynamic project redefinition.

Chapter_4_I presents and explains in detail the elements of a Change Request with an illustrative template. The results of this fourth phase are presented in Chapter_4_II, III, IV, V, VI and VII

Phase 5:

The fifth phase covers a series of case studies to complement our understanding of the different solutions and approaches used by SCE firms and clients to address the project definition and scope evolution.

The last section, Chapter_4_VII, is complemented with the results of the fifth phase of this research. The latter consisted of exploratory case studies of Indian consulting firms working with major north American and European banks, on how to deal with change in project definition throughout a solution's lifecycle. Case studies were conducted with seven (7) top Indian system integration firms that work with large financial institutions in North America and Europe. Twenty one (21) senior managers were interviewed for a period of one to two hours each. This led to six main approaches used by clients and SCEs to address and handle a dynamic project definition. These approaches can be grouped into three categories: 1) the front end of the project or pre-initiation, 2) the unfolding of the project or post-initiation and 3) the global approach.

CHAPTER 2: LITERATURE REVIEW

2.I. Systems Integration

This section covers the first phase of this research where we explore the SCE Game and its dynamics. The characteristics and roles of the multiple players involved in the game are explored and studied. Twelve senior managers from seven top consulting firms in Europe and the Middle East were interviewed for a period of one to two hours. Additional documentation was collected during the interviews and gathered from websites and specialized magazines, articles and white papers.

First we will review the four main strategy paradigms. We notice that system integration cannot be confined to only one of the four strategy paradigms. System integration aims at integrating the internal routines and capabilities of a particular firm as well as integrating different firms to achieve common objectives, namely the implementation of a major IT system.

Then we will see that major IT innovative solutions often involve multiple system integrators that have to collaborate on the solution level while competing on the industry level. The results of the first phase of this research will be presented in this part. This aims at understanding different roles and characteristics of the different players involved in the SCE Game. Furthermore, we will explain the importance of the collaboration process among different partners with respect to the solution's lifecycle.

In conclusion, innovation in this game happens through projects where multiple co-opeting partners engage in a medium to long relationship with one client to achieve the development and implementation of a complex innovative solution.

2.I.A. Strategy paradigms

The field of strategy has considerably evolved in the last few decades. The models can be grouped into two major categories. The first stresses the exploitation of market power while the second focuses on the efficiency (Teece et al., 1997). Each of these two categories can be divided into two sub-categories. This consists of four paradigms which are the following: 1) the competitive forces model which was mainly studied by Porter (1980) 2) the strategic conflict model which was researched by Shapiro et al (1989) and Brandengurber and Nalebuff (1996), 3) the resource base model studied by Penrose (1959) and Rumlet (1984) and 4) the dynamic capabilities that was the focus of the researches of Nelson and Winter (1982) and Teece (1997). Below we will summarize each model, stressing its main characteristics, sources of competitive advantage, strength and weaknesses.

Competitive Forces

The competitive forces model was pioneered by Michael Porter (1980). The industry was analyzed from the industrial organizational economics approach. The firm's competitive advantage was related to the environment in which it competes. Porter identified five industry level forces that influence the behavior of a firm: 1) bargaining power of buyers, 2) bargaining power of suppliers, 3) threats of new entrants, 4) threats of substitutes and 5) industry competitors. The five forces framework provides a systematic way of thinking how these forces interact at the industry level.

Competitive forces approach stresses the different actions a firm can take to alter its position within a specific industry. The competitive advantage of a firm is related to its position within the industry in which it competes. This position is altered and influenced by the (5) forces. Hence a firm should try to decrease the negotiation power of suppliers, increase its negotiation power over customers, build high entry barriers to entrants and sustain competitive advantage over substitutes in order to strengthen its position within the industry. The rent in this framework is based on the firm having a monopoly. Porter suggested three additional strategies a firm can use to ensure a competitive advantage: 1) cost advantage, 2) quality advantage and 3) market segment specialization.

The competitive advantage model is not suitable for rapidly changing technology and market environments. Furthermore, innovation doesn't play a major role in the structuring process of different industries. Finally, it doesn't account for networking, which is becoming a de facto practice in a global and interconnected world.

Strategic Conflict

The strategic conflict model was initiated by Carl Shapiro et al (1989). His approach was based on tools of Game Theory to analyze the nature of competitive interaction among competing firms.

Stanford Encyclopedia of Philosophy defines Game Theory as "the study of the ways in which *strategic interactions* among *rational players* produce *outcomes* with respect to the *preferences* (or *utilities*) of those players, none of which might have been intended by any of them" (Ross, 2006). Game theory has been used in many fields such as biology, computer science and logic, political science, philosophy, sociology and business.

The competitive advantage of the strategic conflict model is a function of the effectiveness with which firms keep their rivals off balance. In a strategic conflict firms learn and develop capabilities to 1) outsmart others, 2) learn from other's behavior, 3) cooperate with others and 4) bargain with others. In other words, firms try to influence the behavior of rivals by pursuing specific strategies such as predatory pricing (Kreps and Wilson, 1982a, Kreps and Wilson, 1982b) or limit pricing (Milgrom and Roberts, 1982b, Milgrom and Roberts, 1982a). Other strategies are based on commitment and reputation (Ghemawat, 1991).

The Game Theory's approach is limited when there are gross asymmetries in the competitive advantage among rival firms. In such cases the results are likely to be obvious. This approach doesn't help small and medium size companies compete with large firms because the forces are simply disproportionate. Large firms can have economies of scale which imply lower cost per unit and higher profit margin. In addition they develop strong networks, reputation and image that tend to influence the client's decision process.

'Value net' is another approach introduced by Brandenburger and Nalebuff (1996). This approach stresses a strategy where firms pursue competition and cooperation or 'Co-opetion' simultaneously. The 'value net' was used as a tool to study the 'co-opetition'. It is composed of the following five players as seen in Figure 2.1: 1) the subject company, 2) the customer, 3) the supplier, 4) the complementor and 5) the competitor.

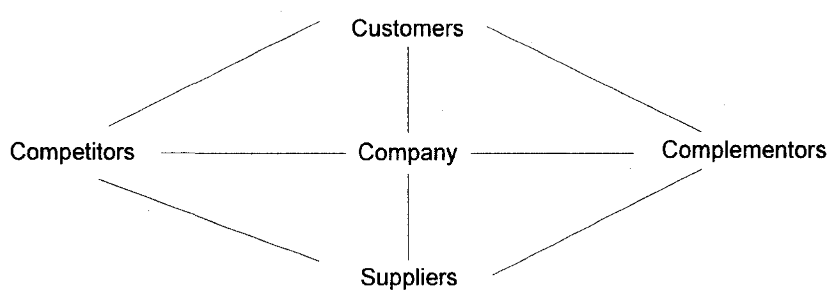

Figure 2.1: Value Net (Brandenburger and Nalebuff, 1996)

The 'Value Net' stresses the importance of cooperation, in a non-contractual relationship, among rival or complementary firms to create value. Value is not created by increasing your market share on behalf of your competitor which is a win/lose situation. Instead, it is generated by increasing the size of the pie which becomes a win/win situation. Hence the added value becomes equal to the size of the Pie when you play the Game minus (-) the size of the pie when you don't play the Game.

The 'Value Net' analysis focuses on the firm and does not account for internal dynamics among the different players. It doesn't consider the resource advantage that a firm can have over other firms.

Resource Base

The resource base model stresses on the firm's internal strengths and weaknesses. It emphasizes firm-specific capabilities and assets (Penrose, 1959). Furthermore, it stresses the existence of isolating mechanisms as the fundamental determinants of firm performance. Hence a firm can have a higher competitive advantage when it capitalizes on its internal resources and protects them by some form of isolating mechanism that prevents their diffusion to the external environment. Every company differs from other firms in terms of the resources it groups. Hence, each firm should identify the strength of its internal resources and capitalize on them in order to build a competitive advantage over its competitors. Furthermore, intra-industry differences in profits are greater than inter-industry differences in profits, which stresses on the importance of firm-specific factors with respect to the relative unimportance of industry effects (Rumlet, 1984). This suggests that firms can earn very high returns when they have superior resources that are not accessible to other firms.

The resource based approach has some limitations which hinder its competitive advantage in an open innovation context where the firm boundaries are permeable for knowledge exchange. This is true in the case of large IT solutions where multiple partners have to work together to implement a solution. A firm can have superior pool of resources and an outstanding accumulated expertise and still not have competitive advantage. On top of its expertise a firm needs to develop capabilities to interact and adapt to a continuously changing and evolving environment. Furthermore, firms see themselves stuck with what they have and may have to live with what they don't have. They lack the organizational capacity to develop new competences quickly and efficiently.

Teece et al. (1997) compare the competitive forces and the resource base approach in terms of their implications for the strategy process. "From the first perspective, an entry decision looks roughly as follows: 1) pick an industry (based on its 'structural attractiveness'); 2) choose an entry strategy based on conjectures about competitors' rational strategies; 3) if not already possessed, acquire or otherwise obtain the requisite assets to compete in the market. [...] From the second perspective, firms are heterogeneous with respect to their resources/capabilities/endowment. Further, resource endowments are 'sticky' [...] the entry decision process suggested by this approach is as follows: 1) identify your firm's unique resources; 2) decide in which markets those resources can earn the highest rents; and 3) decide whether the rents from those assets are most effectively utilized by a) integrating into related market(s), b) selling the relevant intermediate output to related firms, or c) selling the assets themselves to a firm in related businesses" (Teece, 1980, Teece, 1982).

Dynamic Capabilities

The dynamic capabilities approach stresses the ability of a firm to appropriately adapt, integrate and reconfigure internal and external organizational skills, resources, and functional competences to match the requirement of a changing environment. Teece et al (1997) suggest three units of analysis: 1) the processes or routines which include coordination/integration, learning and reconfiguration/transformation, 2) the position of the firm in terms of its intellectual property and assets and 3) the path which accounts for alternative strategies. The competitive advantage results from high-performance routines operating 'inside the firm' and shaped by processes and positions. Firms can evolve and adapt to a continuously changing competitive environment.

Saloner (2001) considers that success stems from a set of actions taken by a firm within a defined context. He stresses three internal issues that a company has to take into consideration in its strategic planning: 1) the firm's Architecture, 2) the firm's internal

Routines and 3) the firm's Culture (ARC). Saloner (2001) considers that strategy is a set of actions taken to increase the firm's performance and profitability. Hence the strategic process is a task in constant evolution.

This approach doesn't account for the complex relationship among several firms or partners that are working on a common solution. The innovation is the result of dynamic routines. A firm's ability to react and alter its routines is important but can't be considered as a strategic objective. Routines that are more administrative and managerial rather than generative and collaborative can hinder innovation. Lastly, a firm that continuously reacts and adapts to the needs of its client could loose its competitive advantage for an emergent disruptive company (Christensen and Overdorf, 2000).

In the following section the concept of system integration will be introduced in terms of the different strategy paradigms discussed above. System integration cannot be confined to one strategic model but is a combination of different paradigms which each contribute to building its competitive advantage.

Strategy paradigms vs System integration

The strategic conflict approach explains how competing firms have to cooperate and collaborate in order to achieve a common objective and respond to a client's need. Clients often hire several system integration firms which are responsible for different but interdependent modules of the same solution. An example would be a client who is implementing an integrated solution that takes into service: firm A for his hardware and infrastructure; firm B for his software and applications; and firm C for his networking needs. Even though each firm on its own is capable of implementing the solution, some clients prefer to deal with more than one firm in order to profit from the best that each firm can offer. This engages firms in some form of non-contractual relationship where they have to collaborate in order to innovate (Brandenburger and Nalebuff, 1996).

On the other hand, system integration firms rely on their resources and dynamic capabilities as a competitive advantage. System integration firms can also be referred to as professional service providers or consulting firms. Such firms are composed of knowledge workers (Davenport, 2005) that sell professional services to clients. Hence these internal resources constitute the main assets of each company. Furthermore, system integrators are firms called upon to manage collaborative and integrative activities of the same major project (Davies and Hobday, 2005). This requires firms to develop dynamic capabilities and routines to structure the collaborative process and permanently adapt to the changing context and to an evolving environment. Systemic integration is considered a core capability that manages the co-evolution and accumulation of knowledge within the firms (Hobday et al., 2003).

2.I.B. Role of the system integrator

The business of system integration is characterized by large firms involved in the coordination of management and business opportunities to accomplish unusually challenging goals (Prencipe et al., 2003). In addition it refers to the integration of the efforts deployed by several firms in a situation of interdependence. Sayles and Chandler (1971) stated: 'an obvious characteristic of modern society is ever increasing interdependency; little can be changed without affecting a wide array of institutions, and many new developments depend upon close, collaborative, and integrated activities that criss-cross organizational boundaries'

Some scholars refer to an integrated system as a solution integrating multiple products and services (Brady et al., 2005, Davies, 2003). Examples of such systems are: 1) commercial ERPs and CRMs or 2) complex proprietary system. These packages aim at integrating knowledge and improve the firm's efficiency.

Most scholars evoke one type of system integration firms (Davies and Hobday, 2005, Geyer and Davies, 2000).

The first phase of this research reveals different types of system integrators or SCE consultants that play different roles depending on the episode of the solution's lifecycle (Nehme et al., 2006). Hence we found the following four groupings of consultants as seen in Figure 2.2 which are associated with the four main phases of the solution's lifecycle: 1) strategy, 2) architecture and design, 3) implementation and project management and 4) operations. Each of these four groups of consultants can be composed of people coming from numerous organizations. A fifth type was also noted. It is a meta-system integrator who defends the client's interests throughout the solution's lifecycle as illustrated in Figure 2.2.

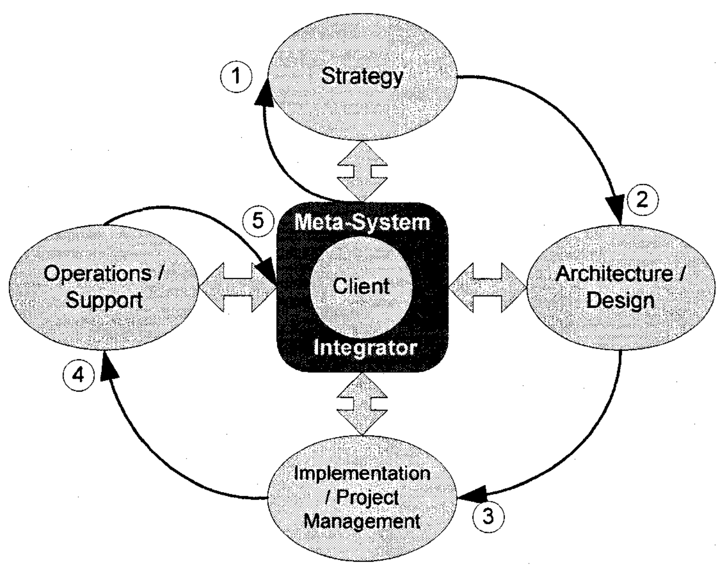

Figure 2.2: Types of consultants

The characteristics of each of the different system integrators with respect to the phase of the solution lifecycle are summarized in **Table 2.1**. Each of the above mentioned groups of system integrators or consultants has its main characteristics and develops its own dynamics in the innovation process of a new information system. The following is a summary of the results of the first phase (Nehme et al., 2006).

Table 2.1: Role of SI through the Solution Life Cycle

	Solution Life Cycle			
SI - System Integrator	**Strategy**	**Architecture**	**Implementation**	**Operation**
Core Capabilities	Knowledge Creative Ideas High Academics High Experience	Technology High-Medium Academics High-Medium Experience	Proj. Management Medium Academics Medium Experience	Organization Oepration/Support Medium-Low Academics Medium-Low Experience
Tools / Routines	Market Analysis & Research Specialized Soft. Simulation Economic & Socio-Political Analysis	Technical Analysis Specialized Soft. Feasibility Study Load Analysis Pilot Project	PM Methodology Tracking Software	Process Diagram User Guide Support Process Communication & Escalation Plan
Stakeholders	Client (Executive) Expert Analysis Regulator - Union Ultimate Client	Client (BU Lead/VP) Product Provider Experts Pressure Group Entrepreneur Users	Client (Director) Program/Proj Mgr Project Team Product Provider Audit - Certification	Client (Functional Leader) Ultimate Client Product Provider Users
Sources of Complexity	Market Competition Fuzzy Goal	Dominant Standard Security	Coordination	Process Optimization Service Level
Role	Strategic Socio-Political	Technological Socio-Political	Project Management	Support
Aspects integrated	Institutional Scope Political Agenda Business Model	Techn. dominance Political Agenda Business Model	Resources Tasks	Services Routines

i. Strategy

A project sponsor enters this phase in order to solve a problem, fulfil a business need or comply with a new regulation. Sponsors may want to adopt new technologies or build mission critical systems to reach new competitive advantages. The output of this phase is an orientation or a road map that the company would follow in the coming phases.

Core Capabilities: Capabilities require a high level view and an understanding of a corporation from a top management perspective. A Strategy SI or Management Consultant is usually an individual that has high academic qualifications and/or high specialized expertise. Large strategy consulting firms such as McKinsey & Co, Booz, Allen & Hamilton, Bain and BCG recruit their consultants from top MBA schools.

Business Week describes the Strategist as a Management Consultant or as "The adviser that tells business what other advisers to use and when".

Tools / Routines: Strategy consulting firms develop specific routines or tools that help them in the decision making process. Firms perform market analysis and research to determine market trend and guide the client through the decision process. On the other hand, every major complex project brings change to any organization and its operations. Strategy consulting firms develop routines to guide the BPR (Business Process Reengineering) and change management process.

When dealing with new technology, several pilot projects could be launched at the same time. Hence some clients decide to use a real option's approach where they would invest in several initiatives and postpone their final decision till the end of the pilot project.

Interaction: From a client's perspective a major project starts at the executive level. Decisions will be taken by a Senior Vice President (SVP) or C-level executives and involve a high level of client and stakeholders interaction.

During this phase the SI has to work with several major parties; one of the players is the regulator which is a state or a government that issues new standards and rules by which a client should conform. Another player is the market analyst with companies such as Gartner or Forrester which provide valuable statistics and market research on the latest trends of technology. The third group of stakeholders is composed of unions or pressure groups such as environmental organizations which could play a major role when building a new nuclear power plant or a hydro electric dam. We also have the users and the ultimate clients who are affected directly by this new project.

Sources of Complexity: The major sources of complexity are related to the market, competition, technology and ambiguous goals. When the driver of a new complex project is a potential new market, it is hard to analyze it because the market doesn't exist (Christensen, 1997). Furthermore, ambiguous goals increase the complexity of the project. On the other hand it is more difficult to understand the outcome of a new technology that has not yet been used by other similar firms.

Finally, the main role of the SI in this phase is Strategic and socio-political. The SI will be integrating the institutional scope, the business model as well as the political agenda of the stakeholders.

ii. Architecture:

The architectural phase aims at transforming the decision or choice reached in the Strategy phase into a global designed solution while taking into account the client needs and characteristics. The first initial phases may overlap before a final decision is reached. The output of this second phase is an architecture which covers the technological aspects of the target solution as well as a socio-political equilibrium among stakeholders. It also specifies the infrastructure that will host the solution and all operating systems and modules related to the solution.

Core Capabilities: The main competitive advantage is related to technology and system knowledge. Staff working in this phase usually has High-Medium academic capabilities (technical or engineering background) and/or are High-Medium expertise.

Tools / Routines: Feasibility studies, load analysis, specialized software and pilot projects were noticed among the different tools and routines used in this phase. Firms such as IBM foster the development of such capabilities and have specialized labs to test new technologies.

Interaction: From the client's perspective the responsibility of the solution is transferred to a VP or a BU leader. A program manager is assigned. Several external parties interact in this phase besides the SI. Among these groups can be found the product\solution provider and the expert. Other stakeholders could be pressure groups, entrepreneurs and users.

Sources of Complexity: The main source of complexity is bridging the gap between the new solution and the current system/architecture. This complexity is mainly technical. This could be related to changes in the current infrastructure or the introduction of a radical innovation. Other challenges could arise such as security, quality and reliability requirements.

In summary the SI role in the architectural phase is mainly technological though some socio-political activities are required. New Technologies will need to be coordinated with current systems as well as the political agenda of the Stakeholders.

iii. Implementation

Once the detailed architecture has been finalized, the implementation phase takes the lead. This is done through a project that transforms the architectural design into an operational solution ready for the end user.

Core Capabilities: The main resource capability is project management. These capabilities can be summarized in nine knowledge areas which are: Integration, Scope, Time, Cost, Quality, Human Resource, Communications, Risk and Procurement (PMBOK, 2004).

Tools / Routines: They consist of various project management plans, project management information system, and earned value techniques. Some tools and routines could use other templates and follow standards such as International Standard Organization (ISO)[3] or Capability Maturity Model (CMM)[4].

[3] http://www.iso.org/iso/en/ISOOnline.frontpage

Interaction: The client is represented by a program / project manager who could be an SI. He interacts with several stakeholders such as: the sponsor, the auditors, the quality department, the solution/product provider, the project team, the project management office and a steering committee.

Sources of Complexity: The main sources of complexity reside in the coordination, conflict resolution, risk mitigation and communication.

Finally, the SI plays the role of a project manager where he will be coordinating different types of resources and tasks to implement the final solution.

iv. Operations

In this last phase the solution is already implemented and operational. It has been transferred to the end user who received appropriate training. The SI could play two roles. The first is to operate the solution and act as an expert end user. This could be through an outsourcing agreement (Brown and Wilson, 2005). The second role is to support and assist the user in the case of a fault or a problem with the implemented solution.

Core Capabilities: The background of the resource can usually be described as low-medium academic and low-medium expertise. SI develops operational expertise and tries to optimize the procedures and service level. The SI has some technical expertise and is responsible for upgrading and maintaining the solution or system.

Tools / Routines: Some of the tools used by the SI are templates and forms, process diagrams and flow charts. Routines are summarized in user guides, communication plans and escalation plans (in case of a problem or an emergency).

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[4] http://www.sei.cmu.edu/cmm/

Interaction: The main stakeholders are the ultimate client, the user and the SI.

Sources of Complexity: Process Optimization and Service Level are the main sources of complexity. The service level could decline with time causing small problems to become high priority. Clients usually expect the SI to continuously improve the service level and response time.

Finally in the Operations phase, the SI supports the solution and the client operations. This SI will be integrating support services and routines.

2.I.C. System integration and Knowledge Workers

In 50 BC, Lucretius in "the Nature of Things – Book V" (Lucretius, 50 B.C.) mentioned that people coordinate their work and collaborate to do more then what they can do alone. From the great pyramids of Egypt to any major project undertaken in today's economy, many people have to collaborate and coordinate their activities to achieve success. Collaboration is not limited to physical work but also extends to mental activities. Friedrich Hayek (1948) pointed out that markets carry out some collective cognition that is beyond the capacity of the individual. Collective cognition applies to projects where individuals gather in order to collectively think about a problem and try to find a solution for it. Large MIS projects usually have a dedicated room for solving technical issues or planning and managerial issues. Such rooms are usually known as 'War' rooms where a 'Swat' team gathers to address a specific problem.

Collaboration is not limited to people working on the project. It should be extended to all stakeholders within and outside the firm. This includes business units and other departments that might be impacted directly or indirectly by the project.

"A robust conclusion emerging from research on innovation processes is that one of the most important factors differentiating successful from unsuccessful innovation has been the degree of collaboration and feedback between product and other corporate functions, especially manufacturing and marketing within the firm (Rothewell 1992:90),(Fagerberg, 2005).

Most people involved in information systems can be considered as knowledge workers. They have "high degrees of expertise, education, or experience, and the primary purpose of their jobs involves the creation, distribution, or application of knowledge. (Davenport, 2005:10)." These knowledge workers can be classified according to the level of complexity of their task and the level of interdependence of their work as illustrated in **Figure 2.3** (Davenport, 2005).

Davenport's classification can be mapped to the four main episodes of the solution lifecycle described above and which is represented in **Figure 2.3**:

Strategy corresponds to the expert model. In the strategy episode the consultant gives the 'wind direction' or what orientation the firm is going to take.

Architecture can be mapped to the collaboration model. Once the strategic direction is given, highly expert and specialized consultants work together to come up with a pilot model or solution.

Implementation corresponds to the integration model. At this stage the solution's design and architecture are known. Consultants engage in large collaborative efforts in order to coordinate multiple activities that should be executed in a specific sequence in order to implement the final solution

Operations can be mapped to the transaction model. The solution is already implemented. All rules and procedures to run the software are well established and known. The consultant executes different batches based on a given routine.

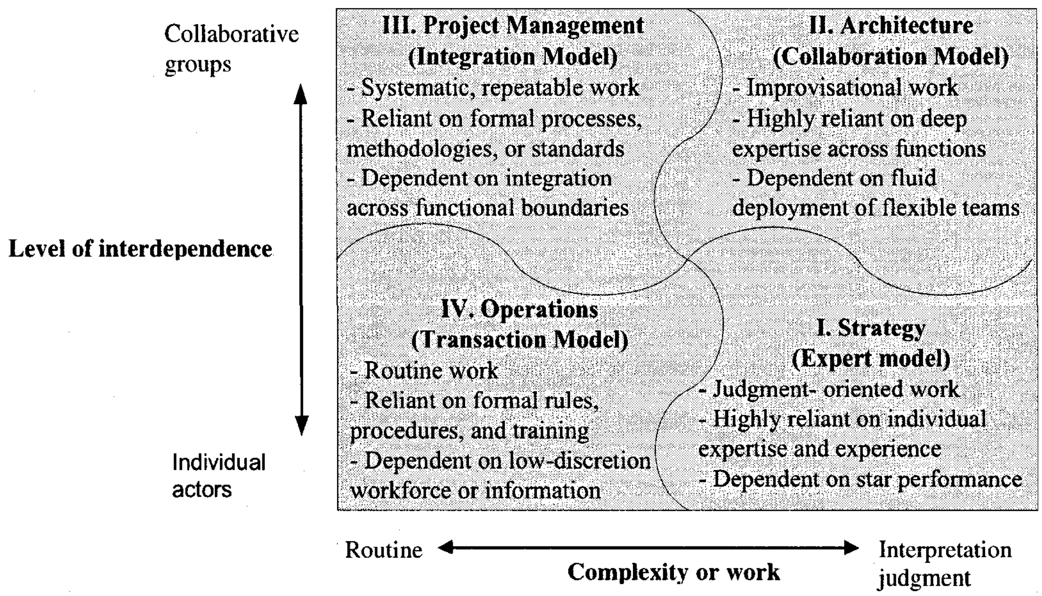

Figure 2.3: Classification - knowledge worker (Adaptation from Davenport (2005))

High collaboration corresponds to the architecture and implementation episodes. In the architecture phase, several experts coming from different organization have to collaborate and engage in generative sessions. This will result in the design of a new architecture that meets the strategic decision. In the integration phase, a large project team composed of individuals coming from different organizations has to develop a new efficient 'shared organizational design' in order to perform and succeed.

In Davenport's Model the lines separating the different types of knowledge workers are straight. We see in **Figure 2.3** that these lines are more curved to indicate that in innovative integrated solutions, project phases overlap and can run in parallel. This will be detailed in subsequent chapters.

2.I.D. Conclusion

In this section we saw that the SCE Game's ecosystem is composed of different system integrators that come from different backgrounds and firms. These system integrators are called upon to work and collaborate on the implementation of a large innovative IT system. System integrators have different characteristics based on their level of interdependence and the complexity of the work they undertake.

The main conclusion we draw from this first phase of our research is that innovation in the SCE game happens through projects where multiple co-opeting partners collaborate to achieve and implement a common client's innovative system or solution. This leads us to focus our research on large complex innovative projects undertaken by large clients. This is the focus of the second and third phases presented in the next section.

2.II. Integrated Systems

As mentioned above, this section explores large innovative IT solutions undertaken by major clients in partnership with multiple system integrators. It covers the second and third phases of this research. The second phase studies ten (10) mission critical IT solutions and their corresponding ecosystems. These solutions are commercial integrated systems that are implemented in five different industries throughout North America. A total of twenty three (23) senior managers were interviewed for a period of one to two hours in addition to a large documentation that was reviewed and analyzed. The commercial solutions studied in this phase can be grouped into 1) mature systems and 2) emerging or growing systems. We can differentiate these two groups in terms of the level of innovation involved in the solution. Mature systems have already developed all their modules and have been implemented in multiple industries and client sites. Innovation degree is low as the implementation process is known and mature. Emerging and growing systems are still forging their path into new industries and developing new modules. Innovation degree is medium because of the unknown associated with each new industry and module. A third group of systems was identified in this phase namely the proprietary or custom systems. Proprietary systems are particular to one major client. Innovation degree is high because such systems are unique and are not replicated from one customer to another. These systems are explored in the third phase explained below.

The third phase studies proprietary solutions that are unique to one large client. It focuses on five (5) proprietary solutions implemented by three large financial institutions. Three of the solutions that are studied are categorized by the financial institutions as highly innovative while the other two have a medium to a low degree of innovation. Interviews with senior and middle management from all system integrators involved in these solutions as well as the clients were conducted. The main finding of this phase is that contrary to common belief, both solutions with high and low degrees of innovation are subject to changes in their project definition along their implementation cycle. Changes are initiated from different elements which will be explored at the end of this section.

2.II.A. Integrated IT Solutions

Before the information systems were integrated, every department within a company used to have its own information system. For instance the financial department, manufacturing department and the human resources departments each had an independent information system. Every department stored information pertaining to its needs. In order to communicate with other departments each system would have to use a common code or 'key' to identify a particular employee or transaction. This would complicate the process as all systems had to stay synchronized in order not to loose track of a transaction or employee. Information was duplicated and stored redundantly in separate databases.

Today, in most firms integrated systems such as Enterprise Resource Planning (ERP) combine all the information that used to be spread throughout an organization, under one main system or database. This streamlines and reduces the number of independent systems required for each firm. In the second phase of this research, where we conducted exploratory case studies to understand mission critical IT solutions, a manager at Pratt & Whitney, who was involved in several implementations of large integrated systems, differentiated between two types of systems: mature systems such as an ERP and growing systems such as PLM.

"[...] the PLM system was not a mature product yet (unlike SAP) because of investments, because of the technology readiness and to some extent to the organizational readiness [...]"[5]

These two systems have different dynamics in their implementation process. Functional modules and implementation process of a mature system are well known. Customers

[5] Interview with manager from Pratt & Whitney on the implementation of the PLM at their firm August, 10 2006

tend to implement a vanilla version of and ERP or commercial integrated system to avoid customization and the effort to finance the evolution of a custom version. Whereas, in the case of a growing system some modules are still in an embryonic stage and the implementation requires more dynamic and innovative approach from all stakeholders. Further exploratory interviews led us to a third type of integrated systems namely custom systems. These are proprietary systems which are unique and can't be replicated from one firm to another.

The following part will start by tracing the evolution of integrated mature systems from a basic bill of material software to a convoluted ERP system composed of different modules and subsystems. Then we will highlight the architectural evolution that happened in parallel to the evolution of integrated systems. Then the particularities of growing systems will be presented. This will be followed by the characteristics of a custom system and proprietary solution which is often associated with a dynamic project definition.

2.II.B. Mature systems – Evolution

The birth of integrated systems can be traced back to the 1960s where the first inventory control packages such as Bill of Material (BOM) applications were used to list all components, subcomponents and parts that make up a system[6]. For example the BOM of a PC would contain a list of subassemblies such as the power supply, the motherboard, the DVD, the Keyboard and so on. The hardware infrastructure of this period had very limited computational capabilities. Furthermore, it was very expensive to purchase a computing system and only large firms had the resources and the volumes that justified such an investment. These legacy systems were based on programming languages such as Cobol and Fortran (Rashid et al., 2002).

[6] http://www.pcmag.com/encyclopedia_term

In the early 1960s, Joe Orlicky who was an IBM employee implemented the first MRP system at J.I. Case in Wisconsin. Shortly after, George Plossl and Ollie Wight implemented an MRP system at Stanley Tool Works in Connecticut (Waddell, 2006).
By the end of the 1960s and early 1970s, IBM introduced a new computer system, the 1401 which was followed by the 360 Series (Garwood, 2002). This hardware and infrastructural innovation had much more computational and algorithmic capabilities. This paved the way for the MRP systems which were one of the first systems developed to improve the logistic chain of industrial firms. MRPs are decision-making methodologies or systems used to determine the timing and quantities of materials to purchase (Vitasek, 2006). MRP could also be defined as 'an information system that determines what assemblies must be built and what materials must be procured in order to build a unit of equipment by a certain date. It queries the bill of materials and inventory databases to derive the necessary elements.[7]'

In the 1980s the Manufacturing Resource Planning (MRPII) was introduced. MRPII consists of a method of planning effectively and optimizing all resources and processes of a manufacturing company[8]. MRPII addresses shop floor and distribution management, financial planning as well as project and human resource planning. Some MRPII systems expanded to include more modules such as Supply Chain Management (SCM) and Distribution Management Systems (DMS). MRP and MRPII were mainly legacy systems based on mainframe technology.

The early 1990s saw the birth of the Enterprise Resource Planning (ERP) system which aims at integrating the data from all aspects of an organization. Mentioned below are a few quotations to define this new system: 'ERP comprises of a commercial software package that promises the seamless integration of all the information flowing through the company-financial, accounting, human resources, supply chain and customer

[7] http://www.pcmag.com/encyclopedia_term/0,2542,t=MRP&i=47327,00.asp

[8] APICS: American Production and Inventory Control Society

information' (Davenport, 1998). 'ERP systems are configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization' (Kumar and Van Hillegersberg, 2000). 'ERP systems are computer-based systems designed to process an organization's transactions and facilitate integrated and real-time planning, production, and customer response' (O'Leary, 2000).

A typical ERP is an enterprise wide system characterized by a single database connected to multiple modules that are dedicated to various business departments such as manufacturing, sales, finance, human resource etc. A company can choose to implement or more modules depending on its main business area and needs. Some examples of ERP modules are the following:

Supply Chain Management (SCM)[9]: covers procurement, inventory, logistics, supply and demand management.

Manufacturing: what used to be MRP and MRPII, accounts for BOM, capacity and workflow management, scheduling, manufacturing quality control and processes etc

Financial: covers the cash flow, accounting, general ledger, asset management etc.

Project Management[10]: accounts for cost, time and expense management of all activities related to a project.

Human Resources: covers payroll, training, benefits and time tracking.

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[9] SCM as defined by the council of Supply Chain Management Professional (CSCMP) "encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies. SCM is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology." (http://www.cscmp.org/Downloads/Resources/glossary03.pdf)

[10] The Project Management Institute defines project management as "the application of knowledge, skills, tools and techniques to project activities to meet the project requirements" (PMBOK 2004)

Customer Relationship Management (CRM)[11]: includes customer contact and call center support, sales and marketing, services, brand management etc. CRM has three fundamental components: 1) *operational* or the automation of business process such as marketing sales and services, 2) *analytical* or the analysis of customer behavior through Business Intelligence and 3) *collaborative* or interaction and communication with clients.

Business Intelligence (BI)[12]: three types of BI can be distinguished: 1) *strategic* to achieve long-term business goals, 2) *tactical* to manage tactical initiatives to achieve strategic goals and 3) *operational right time* to manage and optimize daily business operations (White, 2006).

The above mentioned modules each have their own professional organizations, communities and certifications. These professional networks aim at improving the knowledge base and serve as mediums for knowledge transfer across members.

Among the top providers of ERP systems in the 1990s were the following firms: SAP, Oracle, PeopleSoft, JDEdwards and Baan. Some firms were more reputable regarding certain modules. SAP had a good reputation for its manufacturing and Customer Relationship Management (CRM) modules. Oracle was known for its financial modules while PeopleSoft was selected for its Human Resource Module. Today, and after several acquisitions SAP and Oracle are what remain from the above five mentioned ERP software firms. Baan was acquired by JDEdwards which was bought by PeopleSoft which was acquired by Oracle. Other firms focused on a 1) particular business function and specialized in one module or 2) developed a specific expertise in one industry. Some

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[11] CRM association in United Kindom defines CRM as the establishment, development, maintenance and optimisation of long term mutually valuable relationships between consumers and organisations. Successful CRM, focuses on understanding the needs and desires of the consumer and is achieved by placing these needs at the heart of the business by integrating them with the organisation's strategy, people, technology and business process. (www.crmuk.co.uk)

[12] BI as defined by Wayne Eckerson, director of Research of the The Data Warehousing Institute (TDWI) is "the tools, technologies, and processes required to turn data into information and information into knowledge that drives business activity and optimizes performance.' (email and article)

were successful and became leaders in their field while others failed. Examples of successful firms that focused on business functions: Siebel for its CRM solution, Business Object or Informatica for their BI solutions and so on. An example of a successful firm that focuses on a specific industry is Invera which is Montreal based company considered a leader in its ERP solution for the metal industry.

The evolution of integrated systems is summarized in Figure 2.4:

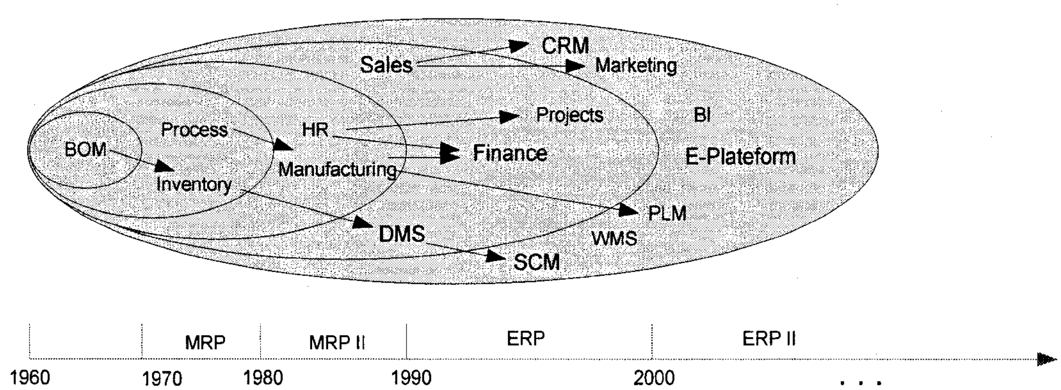

Figure 2.4: Evolution of Integrated Systems

As opposed to their predecessors, ERP systems use multi-tier architecture as illustrated later in Figure 2.6. MRPs were initially developed in a mainframe computer environment (Lindsey, 1997). The mainframe is the main brain and processing unit. User could access and input data through 'Dumb terminal' which didn't have any processing power as seen in Figure 2.5. Later and with the development of a more powerful PC, a client server architecture was used. This allowed some of the processing power to be transferred to the user's PCs.

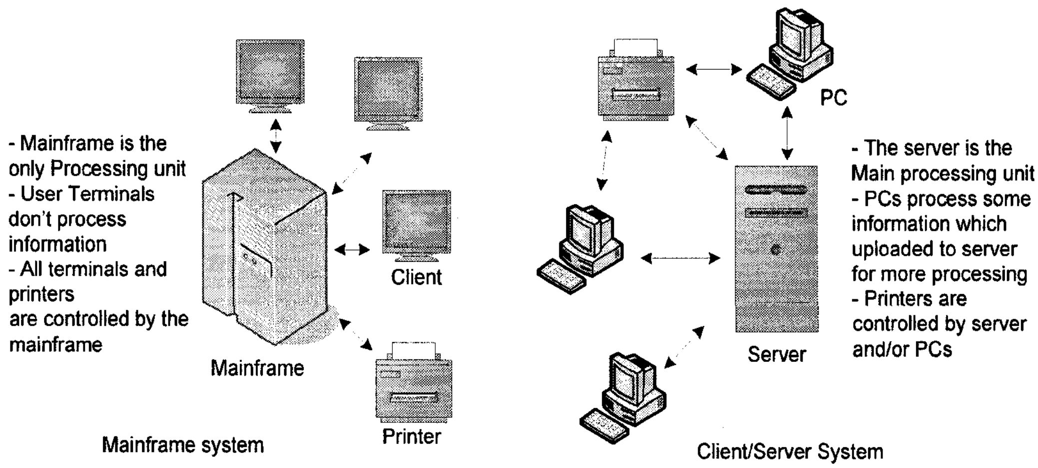

Figure 2.5: Mainframe vs Client/Server

Then the three-tier architecture was developed. It is composed of three layers which are the presentation, application and data tiers. This is illustrated in Figure 2.6.

Presentation Tier: This layer is also known as the user interface. It uses a Graphical User Interface (GUI) which translates raw data into a graphical presentation that is easier to read and understand. The presentation layer has two main functions: 1) It is the interface where client inputs information and requests; 2) it translates the results of the application layer into format tables, reports or graphs.

Application Tier: This layer is responsible for all calculations, logical decisions and evaluations. It includes all business rules, organization's workflows and procedures. It processes and moves information between the presentation and data tier.

Data Tier: This accounts for a powerful relational database used as a repository for all input and generated information. The Data tier interacts with the application tier through queries and different communication channels.

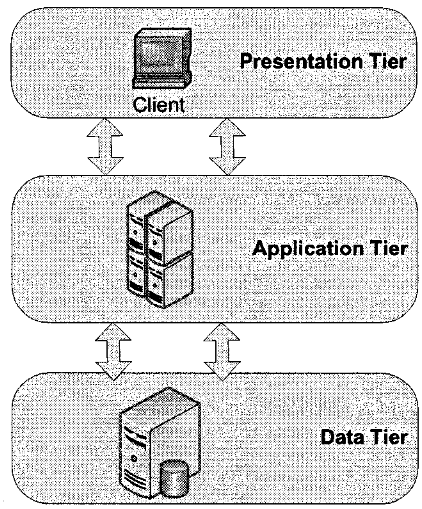

Figure 2.6: 3-tier architecture

Multi-Tier or N-Tier Architecture: Some systems are subdivided into more than three tiers namely multi-tier or what is also known as n-tier architecture. An example is when you subdivide the presentation tier into two layers. The top layer becomes even thinner requiring less computational or processor capabilities. Such n-tier architectures are used when companies want to have their ERP database accessible through any thin client including devices such as mobile phones (Kurbel et al., 2003). These different layers allow each component to be used, replaced or reused, in new combinations that meet particular and dynamic business requirements.

By the end of the 1990s and beginning of the new millennium, ERP systems endorsed the open architecture design. This design allows a company to have an ERP systems composed of modules developed by different software providers. An example is the SAP Learning Solution which endorses an open architecture allowing it to integrate external learning services, such as virtual classrooms and connect to any other content management system.

This new generation of ERP is known as ERPII. Another designation is Enterprise Application Suite (EAS). These suites cover all business segments using a thin client such as an internet browser or mobile device.

The previously mentioned integrated systems can be considered as mature. These systems have been on the market for some time and they are relatively stable and mature. They expanded over all industries and sectors. Most of the modules and required functions have been developed and innovation is less frequent. Their implementation procedures are well known and can be planned in detail. The challenges that face ERP providers are to gain and develop new markets by tailoring their solutions to fit small and medium enterprises.

2.II.C. Growing/Emerging Systems

Growing systems have two characteristics: 1) they are currently used by only a few industries 2) they are still developing new major modules to account for new industry needs. Such systems are forging their way into new markets and their functions are evolving and growing at a relatively rapid pace. Market and functional (new modules) Innovation are highly required to cover new markets and different industries. System and solution innovations are important to account for special needs across different industries and firms. Product Lifecycle Management (PLM)[13] is an example of such a system. PLM systems are facing some challenges such as customization (Lopez-Ortega et al., 2006) and not meeting some business requirements (Orioli and Puppi, 2006). PLM were first introduced in the aerospace, nuclear, military and medical device industries where safety and control are very important and critical (Laumond, 2006, Murphy, 2005, Nathen, 2006, Stephens, 2006). PLM acts as a 1) repository for all information related to a specific product (Crawford, 2006, Stackpole, 2005) and 2) as a collaborative platform among different business units and stakeholders such as engineering, manufacturing,

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[13] PLM : both an umbrella concept and a software solution. As a concept, PLM encompasses all aspects of a product from early requirements, through design, into production and service, and finally recovery and disposal. Practically speaking, the software serves as a central hub for product data, with associated software systems (CAD, ERP, CRM, SCM) obtaining their product-related information from the PLM system and, in some cases such as CAD, creating information for management within the PLM file repository. (http://www.product-lifecycle-management.com/)

marketing and services (Danesi et al., 2006, Legardeur et al., 2006, Ming et al., 2005, Wu et al., 2006). Furthermore, PLM is a tool used for Collaborative Product Innovation (Ming et al., 2005, Sharma, 2005). Collaboration, which is orchestrated by a common tool such as the PLM, is very important in the innovation process of a new product. PLM providers such as Dassault Système (DS) are expanding their product offering into new markets and industries. In December 2004 Hydro Quebec was the first hydroelectric producer worldwide to select a PLM from IBM and DS for the development of hydroelectric projects[14]. This is considered a strategic move where both companies invest to improve their respective competitive advantage. On one hand, Hydro-Quebec wants to acquire a state of the art technology, which has been proved efficient in highly strategic industries such as the aviation industry and in the military, to improve its project development lifecycle and collaboration across its network of design and engineering firms. Jean-Paul Rigg, director, generation engineering, equipment division at Hydro Quebec said:

"With CATIA V5 and SMARTEAM, Hydro-Québec will be able to collaborate more effectively with its partners and expedite the resolution of problems that can occur during the project development stage."[15]

On the other hand DS, through its partnership with a major player such as Hydro-Quebec, is penetrating a new and huge industry namely the Hydro Electric sector. IBM Consulting Services is bridging the technological and business gap of both DS and HQ.

PLM is considered a Growing System because it is still developing new modules as it conquers new industries and markets. A dynamic and generative collaboration is

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[14] http://www-03.ibm.com/solutions/plm/doc/content/news/archive/1205614113.html?printable=yes: IBM and Dassault Systèmes (DS) announced today (01 dec 2004) that Hydro-Quebec has chosen their Product Lifecycle Management (PLM) solutions for the design of new hydroelectric projects. Hydro-Quebec is the first owner-operator in the hydroelectric industry to use digital 3D design technology for the development of its future facilities.

[15] http://www.3ds.com/fileadmin/brands/enovia/Hydro_Quebec_Reference.pdf: IBM PLM helps Hydro-Québec revolutionise the development of hydroelectric projects.

required among several partners to increase the knowledge base and achieve a successful implementation. This happens through pilot projects where partners invest lots of physical and human resources before they can have an ROI.

Mature and Growing systems are developed by one provider and used by many firms. Companies try to adapt their processes to such integrated systems and avoid customization. Hence the cost of updates and upgrades is covered by the system provider and shared among many client firms. Furthermore, the target solution is well known. The implementation lifecycle can be planned ahead in detail and usually follows the linear model.

2.II.D. Proprietary systems

Custom systems are considered 'Home Made' systems in which large companies invest heavily in order to develop proprietary integrated systems. Firms such as banks and financial institutions undertake major investments to develop their own proprietary systems.

Proprietary systems have to adapt to environmental changes while maintaining a reliable and efficient service level. Environmental and contextual change can occur on the organizational level or on the industry as a whole. In the case of organizational change, this could be business related or technology related. In the first case a financial institution has to continuously update its financial product offering and should reflect these business decisions into its solutions and system. On the industry level, new regulations can result from different factors such as regulatory body or socio-political reasons. Thus multiple logics coming from external and internal environments have an impact on the project definition of such systems. Furthermore, proprietary systems coexist with other applications that each has its own evolutionary schedule. This requires the collaboration among different partners and stakeholders. The stakeholders can be different BUs within the same company or external system integrators contracted by the client. In addition, regulations are usually required to be implemented by a fixed date. The latter can be imposed by top management because of some business requirements. This forces the project to be in fast track mode where phases run in parallel in order to meet the target date.

While changes or new functionalities are designed, developed, tested and implemented, the system continues to be used or solicited by clients and customers. Minor changes are usually led by the team responsible for the operations and support, while major changes often require a dedicated team. Major project lifecycle can run in parallel to minor projects lifecycles which increases the complexity of the communication and coordination among multiple stakeholders. Teams working on such changes are composed of individuals coming from different entities that can be internal or external to the client's organization. Internal entities are different Business Units (BU) that partake or are impacted by this change. External entities are consulting and service provider firms, independent consultants and/or software provider firms. Each partner has its own culture, routines, structure and tools. The 'stakeholder' group of factors contributes to generating multiple influences that can have a direct impact on the solution's project definition and scope.

In addition Innovative proprietary systems face three challenges related to uncertainty:

- Technological uncertainty of the solution to be implemented,
- Market uncertainty,
- Solution uncertainty.

Technological uncertainty is mainly related to the technological nature of a project. Information system implementations often involve technological innovations which despite pilot projects cannot guarantee the performance of the newly implemented solution.

In the case of Market uncertainty, the softwares used in a system become obsolete and unsupported by the providers and hence require an upgrade. For example the Software Support Lifecycle of IBM determines an 'end of support date' for every release/version of the Websphere Application Server (WAS) software.[16] Every software upgrade should go through a project lifecycle requiring testing and often changes to the system's code. Change could also result from an industry regulation such as the Sarbanes Oxley Act of 2002[17] or the Basel II Accord of 2004[18]. Financial institutions have to abide by such regulations and hence engage in large complex projects to bring the required changes to their systems.

Solution's uncertainty can also be the result of poor business needs definitions. It can also result from a high level design documentation that is interpreted differently by multiple partners who are to collaborate in order to achieve a common project.

In summary, the second and third phases of this research consisted of an exploratory study to understand mission critical IT systems and projects undertaken by large clients. This lead to a differentiation among three categories and types of integrated systems:

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[16] IBM Software Support Lifecycle: http://www-306.ibm.com/software/info/supportlifecycle/

[17] http://www.sarbanes-oxley.com/section.php : SOX Act: To improve quality and transparency in financial reporting and independent audits and accounting services for public companies, to create a Public Company Accounting Oversight Board, to enhance the standard setting process for accounting practices, to strengthen the independence of firms that audit public companies, to increase corporate responsibility and the usefulness of corporate financial disclosure, to protect the objectivity and independence of securities analysts, to improve Securities and Exchange Commission resources and oversight, and for other purposes.

[18] http://www.federalreserve.gov/generalinfo/basel2/ : Basel II is an effort by international banking supervisors to update the original international bank capital accord (Basel I), which has been in effect since 1988. The Basel Committee on Banking Supervision, on which the United States serves as a participating member, developed the current proposals. They aim to improve the consistency of capital regulations internationally, make regulatory capital more risk sensitive, and promote enhanced risk-management practices among large, internationally active banking organizations.

Mature systems such as a Material Resource Planning (MRP) or an Enterprise Resource Planning (ERP),

Growing systems such as a Product Lifecycle Management (PLM),

Proprietary systems or 'home made' systems where large companies invest heavily in order to develop proprietary integrated systems. The third type of integrated systems namely the proprietary category is associated with the highest level of innovation and complexity because of its uniqueness

Change is permanent and present in all IT projects and at different points of the solution's lifecycle. Multiple influences that are exogenous to the project boundaries and emerging uncertainties that are endogenous to the project play an important role in shaping the project definition and scope throughout the implementation lifecycle of such solutions. This is summarized in Figure 2.7 below.

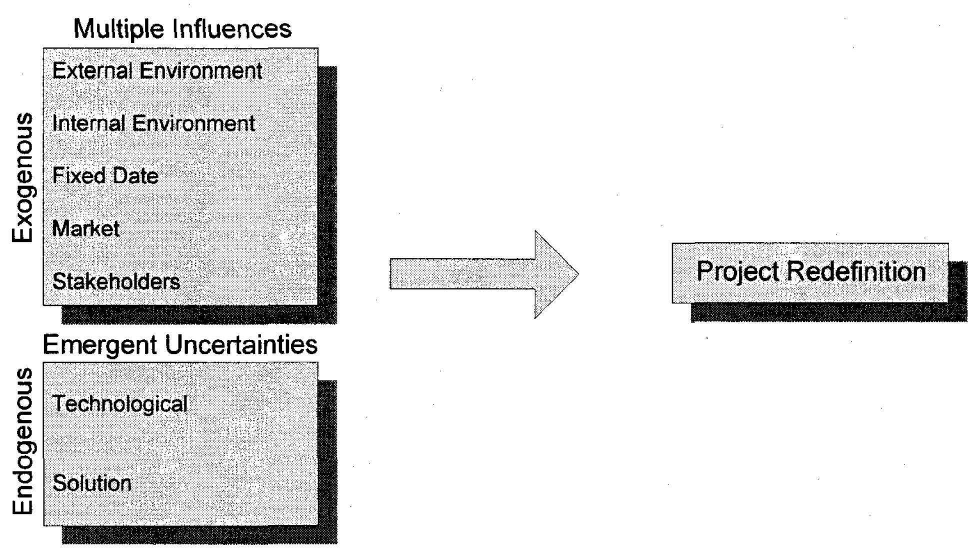

Figure 2.7: Integrated system factors

2.III. IT Success Factors

This section will review different frameworks and line of research that studied the implementation of integrated systems in large firms. It focuses on the Critical Success Factors (CSF) for implementing different management information systems (MIS). Although it is important to know these factors, we can't guarantee success if we don't understand the dynamics of the innovation process that accompany proprietary innovative solutions.

The CSF models don't account for change in the project definition. Projects tend to be measured against their initial scope. Zhang et al (2005) refer to a recent Standish Group report on ERP implementations which reveals that these projects were, on average, 178% over budget, took 2.5 times as long as intended and delivered only 30% of promised benefits. Despite these figures and even if ERP system implementation exceeds contracted delivery time and budget; many firms still consider their ERP implementation a success. This can be explained because project definition evolves over time and throughout the implementation process. It has hardly been measured or taken into account by researches who studied the CSF for implementing integrated systems. Our research studies project definition and scope evolution along the implementation lifecycle of an innovative integrated solution. We can see below that some of the success factors listed in the literature can be sources and reasons for a dynamic project definition and scope evolution in the case of innovative proprietary solutions.

As a background for this research a few terms will be clarified: MIS and CSF. MIS, refers to Management Information System, and can be defined as a computer-based organizational information system which provides information support for management activities and functions (1980). CSFs (Critical Success Factors) in general refer to a few areas in which satisfactory results will guarantee successful competitive performance

(Bullen and Rockart, 1981). More specifically, in the case of an MIS, CSFs are the key areas where 'things must go right' for the implementation to be successful (Xue et al., 2005). Most of the research that studied CSF used a causal model (A leads to B or IF A then B). This provided a list of factors that should be taken into consideration or stressed to ensure a successful system implementation.

The following will analyze the critical success factors from 3 main views: 1) the IT focused view, 2) the environmental view and 3) the ensemble view. At the end of each view a summary of the elements that will be retained as independent variables for the conceptual model of this research is presented. Next will be discussed the most common success factors found in the literature. This will be summarized in a table representing the authors that studied each factor. Finally, summary of the elements retained from these 3 main views and that can contribute to project definition evolution of innovative complex IT solutions.

2.III.A. IT focused view

Delone and Mclean developed in 1992 a framework and model for measuring the complex dependent variables in information system research. This research model (D&M) was based on the communications research of Shannon and Weaver (1949) and the information influence theory of Mason (1978). Shannon and Weaver defined three levels of communication:

1) technical level (accuracy and efficiency of the communication system that produces information);

2) semantic level (success of the information in conveying the intended meaning);

3) effectiveness level (effect of the information on the receiver).

In the D&M model, systems quality is used to measure technical success and information quality is used to measure semantic success. Moreover, user satisfaction, use, individual impacts and organizational impact are employed to measure effectiveness success. The model is presented in Figure 2.8:

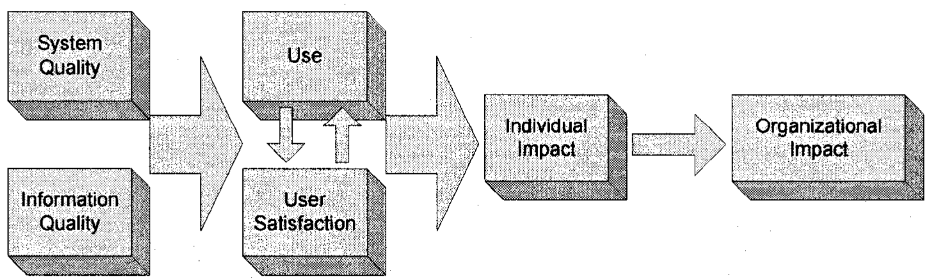

Figure 2.8: IT focused view (Delone and McLean, 1992a)

Delone and McLean validated this model against 180 empirical studies classifying dimensions of information systems success into six categories: system quality, information quality, use, user satisfaction, individual impact and organizational impact. Since then, many empirical studies tested and validated the links among these dimensions. The strongest links are summarized below:

- *System use* vs *individual impacts: System use* (measured as frequency of use, time of use, number of access, usage pattern and dependency) was found strongly correlated to *individual impacts* (measured as job and decision making performance) (Goodhue and Thompson, 1995, Guimaraes and Igbaria, 1997, Igbaria and Tan, 1997, Teng and Calhoun, 1996, Torkzadeh and Doll, 1999, Weill and Vitale, 1999, Yuthas and Young, 1998).

- *System quality* vs *individual impacts: system quality* (measured in terms of ease of use, functionality, reliability, flexibility, data quality, portability, integration and importance) was strongly correlated to *Individual Impacts* (Goodhue and Thompson, 1995, Etezadi-Amoli and Farhoomand, 1996, Seddon and Kiew, 1994).

- *Information quality* vs *individual impacts: Information quality* (measured in terms of accuracy, timeliness, completeness, relevance, and consistency) was strongly linked to -

- *individual impacts* (Etezadi-Amoli and Farhoomand, 1996, Seddon and Kiew, 1994, Wixom and Watson, 2001, Teo and Wong, 1998).

Ten years after they first published their model, Delone and McLean came out with a revised enhanced model that took more into consideration the e-commerce environment. The model is presented in Appendix B. The enhancements can be resumed in the following: 'service quality' was added to the 'system quality' and 'information quality'. 'Individual impact' and 'organizational impacts' were merged into 'net benefits' (DeLone and McLean, 2003).

This model inspired many researchers who used and tested its dependent variables. Even though many consider that Time Quality and Cost are the main indicators of a successful project (PMBOK, 2004), the variables used in the Delone and McLean model proved to be often more relevant. A large number of IT projects were over budgeted and took more time and were still considered very successful. Ninety percent of ERP implementations are late or over the budget (Martin, 1998) and still many implantations are considered successful. This can be explained because the main element of a project definition which is scope evolves during the implementation lifecycle of a project. This has an impact on the secondary elements which are Time, Cost and Quality. The dependent variables will be addressed in the next section.

In the case of large innovative IT projects, system quality cannot be 100% guaranteed by the initial design despite pilot projects. The project design will evolve along the solution lifecycle and adjust according to new data and test results. This can be related to technological uncertainty. The latter can be related to performance and compatibility as we cannot guarantee the behavior of a new system when hooked to company's infrastructure.

2.III.B. Environmental View

Ives et al. (1980) proposed a more comprehensive model based on descriptions and evaluations of five existing MIS research frameworks:

1) Mason and Mitroff (1973),
2) Chervany, Dickson, and Kozar (1972),
3) Lucas (1973),
4) Mock (1973) and
5) Gorry and Scott Morton (1971).

This model was partially validated by mapping 331 MIS Ph.D. dissertations into the framework. The model is presented in Figure 2.9 and states that there are 3 IS environments, 3 IS processes and the information subsystem. All of these exist in an organizational environment and an external environment. The environmental characteristics define the resources and constraints, which dictate the scope and form of each information subsystem.

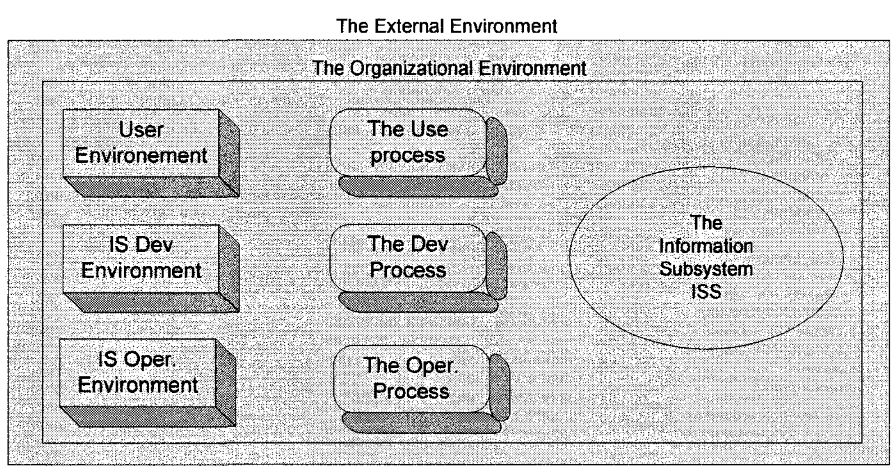

Figure 2.9: Environmental view (Ives et al., 1980)

The variables associated with each box are detailed in appendix B.

The external and organizational environments justify or motivate the implementation of a new information system. A new regulation emanating from the external environment can force companies to implement changes or new systems to comply with standards or security measures. Similarly, a new business or organizational need can induce the purchase or development of a new MIS.

On the other hand, a system is usually shared by multiple environments:

1) User environment can be clients using the system as a tool for their business. Such as a salesperson who places an order through an MIS purchasing module.

2) IS development environment consists of a development team composed of resources coming from different partners and working on a common MIS project. For example the implementation of the CRM solution at Hydro Quebec required a dedicated team composed of resources from SAP, IBM, independent consultants and different BUs within Hydro Quebec.

3) IS Operations environment is composed of technical resources supporting and maintaining the system as well as solving technical problems reported by users. I.e. a bank relies on its operations team to keep its system running non stop. This operations team is ready to intervene in the case of a problem or system fault. Furthermore this team will provide support for the end user.

The different environmental variables will be considered in this research. These variables are also responsible for scope changes and hence can have a direct impact on the entire project definition. The first 2 variables (external and organizational environment) are needed as a raison d'être for the implementation of an IS. And the remaining three variables are the user, the developer and the operator and can belong to different BUs within a client organization. Each has its own environment, context and structure which are interdependent. The above mentioned variables can generate multiple influences that can have an impact on the project definition. Large IT innovative projects are shaped by multiple influences emanating from environmental variables. Environmental event or changes occur during the project lifecycle and can lead to project redefinition and scope changes.

2.III.C. IT model and Environmental model

While many researchers tested the variables of the previously mentioned models, others developed new models using a combination of variables from each model. Zhang et al (2005) developed a new model where the dependent variables where extracted from the D&M model while the independent variables inspired from the Ive et Al model. The resulting model has the following independent global variables: organizational environment, user environment, system environment and system/software environment. The dependent variables which represented the implementation success were: user satisfaction, individual impact, organizational impact and intended business performance.

2.III.D. Ensemble View

The ensemble view focuses on the interaction between the technology and the people (Orlikowski and Iacono, 2001). It postulates that there is no one recipe for the implementation of an information system. Because MIS are designed, implemented and operated by people they are shaped by a large community of stakeholders which have their particular culture, interests and values (Xue et al., 2005). Orlikowski and Iacono (2001) state: "IT artifacts are always embedded in some time, place, discourse, and community. As such, their materiality is bound up with the historical and cultural aspects of their ongoing development and use, and these conditions, both material and cultural, cannot be ignored, abstracted, or assumed away (p. 131)." Xue et al developed their framework using a combination of the ensemble view and the IT focused view Figure 2.10.

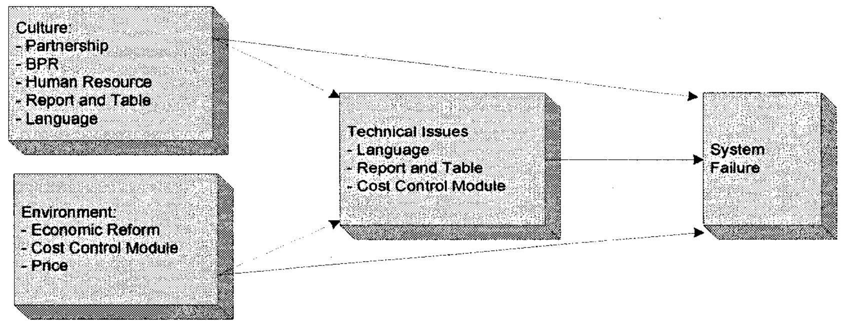

Figure 2.10: Ensemble view (Xue et al., 2005)

The theoretical model is based on the ensemble view and the IT focused view of an information system's implementation. The ensemble view treats the cultural and environmental aspects whereas the IT focused view or Delone and McLean (1992a) model postulates that system quality and information quality are two central dimensions of IS success.

A client implementing a new information system engages in a long term relationship with several partners which can be service provider firms, independent consultants, software or hardware vendors etc. This implies that people coming from different firms have diverse organizational cultures and values and have to work together to reach a 'common objective'. Different partners can have different initial objectives which should be aligned towards a common goal that all stakeholders should contribute to. Furthermore, each partner has developed, in his own organization, his own routines and procedures which might not be aligned with the other players. This constitutes another challenge namely to have everybody use compatible reporting tools that serve simultaneously the needs of the project and their respective organizations. Finally multiple system integrators working on a common solution can be competing on the industry level. Hence, they are subject to a co-opeting environment where they have to collaborate with a partner on a project level while they are competing with the same partner on the industry level. This is also a source of multiple influences that can have a direct impact on the evolution of a project definition along the lifecycle of the solution.

2.III.E. Summary of CSF

The following discusses the most common success factors found in the literature. A summary of these success factors and the authors that studied them is presented in **Table 2.2**.

1) Top Management Support: An IS implementation involves several BUs of an organization and has a considerable impact on the resources at different levels. Some managers, usually IT managers feel that they will have more power in the company because they will control all the information. Whereas other managers, such as human resource managers who usually have considerable authority in a firm, feel that they will lose part of their notoriety and become more dependent over a technology. Most researchers consider that leadership and top management commitment are the most important success factors for a new system implementation (Al-Mashari et al., 2003a, Ives et al., 1980, Pairat and Jungthirapanich, 2005). Furthermore, top management support is crucial in settling disputes and providing clear direction (Zhang et al., 2005). Ang et al (2002) state that Top Management support leads to: 1) effective project management, 2) company-wide support, 3) good education and training and 4) data accuracy.

Sum et al (1997) stressed that top management can have three facets: showing interest, providing the necessary resources, and showing leadership. They add that top management should formally form a steering committee to track, review and monitor the progress of an implementation. The project should be spearheaded by a highly-respected, executive-level project champion (Umble et al., 2003).

2) Business Process Reengineering (BPR): Hammer and Champy (1993) define Business Process Reengineering as: "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed". Hence to take advantage of a new system such as an ERP a firm should review and be flexible to adapt its business processes. BPR is often underestimated by many firms.

Some successful companies, rather than integrating the ERP-Software into existing business processes, draw their process requirement needs and select the system that best fits these needs to the greatest extent possible (Ehie and Madsen, 2005).

3) Project Management: an integrated system implementation is often achieved by a project team with a strong Matrix structure (where individuals would report to more than one Manager – their original functional manager and their new project manager). In some cases the strong matrix is replaced by a projectized structure were individuals stop working for their functional unit and become dedicated to the new system implementation project. The project manager/leadership plays a major role and he needs to have considerable authority and decision making power attributed by top management.

Ang et al (2002) consider that effective project management leads to: 1) selection of suitable hardware and software, 2) selection of good and supportive software vendor, 3) data accuracy and company-wide support.

4) Clear Goals, Vision & Objectives: One of the most fundamental elements in business improvement is having a clearly defined vision/mission and the formulation of the right policies/strategies that can serve as a blueprint for any organizational success (Mitchell and Zmud, 1995). Al-Mashari (2003a) stresses that successful visions or missions are those that can be translated into measurable goals and targets. Hence "right from the outset of the implementation, it should be clear that making (a system) work is a common GOAL" (Sum et al., 1997). According to Umble et al (2003), a system implementation requires that top management create a clear vision of how the company should function. Hence their must be a clear definition of goals, expectations, and deliverables. So the firm must clearly and carefully define the reason for which the new system is being implemented as well as the critical business needs that the system addresses.

5) Training and education: Training and education are important factors to the team developing and/or implementing a new system but also to the team that will support and maintain the system. After its implementation an MIS will be transferred from the project team to the operations and maintenance team which will take the responsibility of supporting the users, maintaining and upgrading the system. A successful operational transition can be ensured by proper training and education.

6) Team Work Composition: Shanks et al (2000) stress the importance of the team composition. They consider that in the case of a major system implementation team members should be dedicated to the project. Moreover, the team should be composed of a mix of IT and business individuals with a very good understanding of business processes. They also consider that external consultants play an important role in such a team because they bring external knowledge and expertise.

7) Change Management: Every new solution, module or even function brings change and can potentially have an impact on a user or a client. Change management process should involve all parties directly and indirectly concerned by the new solution. Many resources can be reluctant to change or be afraid of loosing their position or their seniority with respect to a particular application. Change management is therefore a very important process to be taken into account when implementing a new solution.

8) Communication: PMI considers that 80-90% of a project manager's task is communication. This factor constitutes a major element when it comes to implementing a new complex and strategic system and integrating a large group of resources coming from different backgrounds and cultures.

Furthermore a communication process or plan should be established within each project. This process should provide information to all participants and the company regarding the advancement of the implementation as well as the milestones that each individual should meet. Proper information should be addressed to management to take proper decisions and resolve problematic issues. A good communication plan helps the project team mitigate and avoid many risks and problems.

The communication plan has to detail several areas including the rationale for the new system implementation, details of the business process management change, demonstration of applicable software modules, briefings of change management strategies and tactics and establishment of contract points (Bancroft et al., 1998). Communication has to cover the scope, objectives, and tasks of the system implementation project (Summer, 1999).

To avoid the various communication failures, an open information policy has to be maintained for the project (Al-Mashari et al., 2003a). A good intranet system helps promote the information sharing. A war-room should be dedicated to the project were major issues and problems can be addressed. In the case of multi-location implementation, a conference bridge or a Webex (internet conference medium where presentations, videos, voice etc can be shared) to the project team.

10) Suitability of Hardware & Software: a careful selection of the hardware and/or software for a new integrated system implementation is also an important success factor (Ang et al., 2002).

11) User Characteristics: The characteristics of the end user play an important role in an MIS implementation success. Users can have different education levels, characteristics, be technically-oriented or business oriented (Ives et al., 1980). Younger users are more familiar with IS and are more willing to adapt to change whereas pre-retirement users would have a higher resistance to change. The latter will feel a higher level of stress.

12) User Participation: User involvement refers to the participation in the system development and implementation processes by representatives of the target user groups (Zhang et al., 2005). Many authors stress that user involvement in the development (i.e., purchase, design, modification, or implementation) of an IS is a very important factor in its success (Mandal and Gunasekaran, 2002, Yusuf et al., 2004). Users should be involved in Business Process Review and their feedback should be taken into consideration because they will live with the system and the new procedures. So when they take part in the decision process they will be more supportive and willing to make the implementation a success.

14) Company wide support: This refers to the Human Resource factors and includes having the support of all departments, in addition to sharing and communicating the implementation goals. Since a major system implementation involves most BUs, it's important that all functional departments be involved in the whole process. Company-wide support can involve the following: 1) extent of trust and usage of the new system, 2) giving the people sufficient time to "adopt" the system, and 3) establishing clear goals (Sum et al., 1997).

17) Data Accuracy & Integrity: the different modules or applications of an integrated system are interrelated and communicate amongst each other on a permanent basis. The modules depend on each other and on the data exchanged among each other. 'Garbage in' leads to 'garbage out'. Inaccurate data input into one module will affect the proper functioning of other applications. Thus, information quality is a major determinant of an MIS success (Xue et al., 2005, Zhang et al., 2005, Yusuf et al., 2004).

18) Vendor Support: The more supportive the software vendor is, the higher is the probability of new system implementation success is (Ang et al., 2002). Vendor reputation can be an indicator of the level of support that can be expected from a specific provider. The time response and the time required for the resolution of a reported problem is also a very important indicator to take into account.

19) Company Expertise in IT: Some companies are more familiar with IT than others. Most employees in a high tech company (cable / chip / telecom) are familiar if not expert with information technology. Hence the process of going through the learning curve of using the new system is much faster than in other companies. Some manufacturing or agricultural firms have a low percentage of employees that deal with IT on a daily basis. With a new IS, more users will have to rely on IT to complete their tasks. Furthermore a company that has a good expertise in IT usually has an up to date IT infrastructure and users are already dealing with up to date software versions and systems. The change tends to be incremental rather than radical.

20) System Quality: The IS quality is an essential factor to the success of an implementation. The quality could be measured by the number of bugs or errors, robustness of the system as well as its performance. Another indicator of quality is the user interface and the reports that are produced by the system. Hence a system with coherent and friendly user interface would result in a faster adoption by the end user. Xue et al (2005) found that the report and table format presentation had a direct impact on the Chinese end users. User resistance will likely result because of alien presentation styles.

21) Partnership: Xue et al (2005) studied (5) cases of Chinese companies implementing Western ERP systems that had to deal with local service providers to overcome some cultural and language issues. They noted that "By Switching to domestic service providers or international service companies familiar with the Chinese culture, foreign ERP vendors can mitigate the pressures exerted by Chinese culture which values personal relationships. However, partnering with local service providers creates another problem for foreigner ERP vendors: Training". In such cases the ERP Vendor would be providing "Train the Trainer" activity while the service provider would be training the users.

An IS implementation often involves a long term partnership that spans over 5, 10 or even 15 years. Some firms engage in outsourcing agreements with large service providers (Brown and Wilson, 2005).

21) External Environment: Among the five classes of environmental variables identified by Ives et al (1980) is the External Environment. This includes legal, social, political, cultural, economic, educational, resource, and industry/trade considerations. Due to China's economic reforms, Chinese companies are under pressure to transform themselves into market-driven enterprises. The rapid opening of China's markets led to such abrupt changes that some companies are still not ready to adopt. In China, firms change their purchasing plans frequently, leading to a requirement for raw material cost to be updated frequently to represent the latest market prices. Whereas in Western firms purchasing plans are normally made at monthly or yearly intervals and raw materials' prices are somewhat fixed (Xue et al., 2005). On the other hand a new regulation such as the BASEL II Accord or Sarbanes Oxley's act can force financial institutions to alter their information system. Hence banks engage in large projects to bring major changes to their proprietary systems in order to have it comply with the new regulations.

25) IS Cost/Price: "Business Process integration is more costly, almost by a factor of 3-10 than the MIS software itself" (Ehie and Madsen, 2005). What drives the cost upward are: high consultancy fees charged by system integrators, heavy reengineering focus generally adopted by implementing companies, and the need to replace high percentage of existing technology infrastructure. While the system-based costs averaged 40% of the total cost, the remaining 60% of the cost goes to training and professional services (Mabert et al., 2003). Most companies base their IS purchase and implementation on the price and they fail to account and consider the remaining investments required for the implementation. Cost of IS implementation typically ranges from 2 to 6% of annual sales. Implementing an IS system requires a thorough strategic thinking that allows companies to gain better understanding of their business processes (Ehie and Madsen, 2005).

The following table summarizes the major success factors that were identified and researched. This table was initially inspired by the articles of Zhang et al (2005) and Pairat and Jungthirapanich (2005) then validated and extended to cover other papers in this research.

In conclusion this section analyzed three main views that studied CSF for implementing an MIS or an integrated solution. None of these views addresses the management of a dynamic project definition and scope as an important element to take into account when implementing innovative IT solutions. Scope tends to be frozen at the end of the architectural and design phase. It is considered stable all through the implementation phase.

Table 2.2: Summary of the most common Success Factors found in literature (1/2)

CSF	Total	(Ives et al., 1980)	(Delone and McLean, 1992b)	(Roberts and Barrar, 1992)	(Wilson et al., 1994)	(Sum et al., 1997)	(Falkowski et al., 1998)	(Bingi et al., 1999)	(Buckhout et al., 1999)	(Holland et al., 1999)	(Stefanou, 1999)	(Summer, 1999)	(Rosario, 2000)	(Scheer and Habermann, 00)	(Shanks et al., 2000)	(Wee, 2000)	(Murray and Coffin, 2001)	(Ang et al., 2002)	(Somers and Nelson, 2001)	(Hong and Kim, 2002)
Top Management support	23	x	x	x	x	x		x	X	x		x			x	x	x	x	x	
BPR	23	x		x				x		x		x	x		x	x	x	x	x	x
Project Management	21	x				x	x	x		x		x	x		x	x	x	x	x	
Clear Goals, vision & objectives	15	x	x	x			x		X	x			x		x	x		x	x	
Training and education	15	x	x			x											x	x	x	
Team Work Composition	13						x	x	X	x	x	x	x		x	x			x	
Change Management	13			x			x	x		x		x	x		x	x	x		x	
Communication	12						x			x		x	x		x	x		x	x	
Project Champion	9						x				x	x	x		x		x		x	
Suitability of hardware and software	8	x				x												x		
User characteristics	8	x	x		x			x										x		x
User participation	8	x	x					x										x		
Sofware Dev & Testing	8							x		x			x	x		x	x			
Company-wide support	7		x		x	x												x		
Cultural Fit	7	x	x																	x
Monitoring & evaluation of perfor.	7			x			x			x		x	x				x			
Data accuracy and integrity	6					x												x		x
Vendor support	5					x		x											x	

CSF	Total	(Ives et al., 1980)	(Delone and McLean, 1992b)	(Roberts and Barrar, 1992)	(Wilson et al., 1994)	(Sum et al., 1997)	(Falkowski et al., 1998)	(Bingi et al., 1999)	(Buckhout et al., 1999)	(Holland et al., 1999)	(Stefanou, 1999)	(Summer, 1999)	(Rosario, 2000)	(Scheer and Habermann, 00)	(Shanks et al., 2000)	(Wee, 2000)	(Murray and Coffin, 2001)	(Ang et al., 2002)	(Somers and Nelson, 2001)	(Hong and Kim, 2002)
Company expertise in IT	4	x																x		
System & Business fit	4			x						x										
Partnership & consultants	4																		x	
Economic/Political Env	4	x	x		x															
System Quality - Report & table	3																			
Visibility of Implementation	2																	x		
System Price	2																			
Language	1																			

Table 2.3: Summary of the most common Success Factors found in literature (2/2)

CSF	Total	(Motwani et al., 2002)	(Mandal and Gunasekaran)	(Stratman, 2002)	(Al-Mashari et al., 2003a)	(Nah et al., 2003)	(Esteves et al., 2003)	(Malbert et al., 2003)	(Umble et al., 2003)	(Xue et al., 2005)	(Zhang et al., 2005)	(Yusuf et al., 2004)	(Ehie and Madsen, 2005)
Top Management support	23		x	x	x	x		x	x	x	x	x	
BPR	23	x	x	x	x	x	x	x	x	x	x	x	
Project Management	21			x	x	x	x		x	x	x	x	x
Clear Goals, vision & objectives	15			x		x			x			x	
Training and education	15		x		x		x	x	x	x	x	x	x
Team Work Composition	13			x		x	x						
Change Management	13			x		x	x						
Communication	12				x	x	x					x	
Project Champion	9					x	x		x				
Suitability of hardware and software	8		x		x			x				x	x
User characteristics	8									x	x		
User participation	8		x								x	x	x
Sofware Dev & Testing	8					x	x						
Company-wide support	7									x	x	x	
Cultural Fit	7				x					x	x	x	
Monitoring & evaluation of perfor.	7					x							
Data accuracy and integrity	6							x	x	x			
Vendor support	5	x										x	

CSF	Total	(Motwani et al., 2002)	(Stratman, 2002)	(Al-Mashari et al., 2003a)	(Nah et al., 2003)	(Esteves et al., 2003)	(Malbert et al., 2003)	(Umble et al., 2003)	(Xue et al., 2005)	(Zhang et al., 2005)	(Yusuf et al., 2004)	(Ehie and Madsen, 2005)
Company expertise in IT	4						x				x	
System & Business fit	4		x			x						
Partnership & consultants	4					x			x			x
Economic/Political Env	4								x			
System Quality - Report & table	3								x	x	x	
Visibility of Implementation	2										x	
System Price	2								x			x
Language	1								x			

2.IV. Project Definition and Success indicators

This section will present the main elements of a project definition which are: scope, organization, time, cost and quality. Each element will be explained and supported by some examples. These elements are often interdependent meaning that a change in one can lead to a change in the other. The five elements can be used to measure and track project performance and success. Most firms tend to use one or two of the five elements (time and/or cost) as the main indicators of their project success. They don't take into account for example the scope evolution emanating from external factors and which is often responsible for changes in the time and cost baselines of the project.

This will be followed by a literature review of the main success indicators mentioned by researchers that studied firms that had undergone a large system implementation. We can then notice the lack of the scope and organizational elements as indicators. These will be considered in our conceptual model. Finally a summary of the elements retained for the conceptual model of this research will be presented.

2.IV.A. Elements of a project definition

Turner (1993:7) defines a project as: "an endeavor in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives." Turner (1993:7) expands this definition to Operations: "Delete 'in a novel way', and replace 'unique' with 'repetitive', and this definition might apply to operations." This definition explains that a project is characterized by five elements which are: 1) Scope, 2) Organization, 3) Quality, 4) Cost and 5) Time. This is illustrated in Figure 2.11.

Furthermore it's important to note that project scope is driven by the project objective, purpose or what could be considered as a "beneficial change". Below, we review each of the five elements mentioned above.

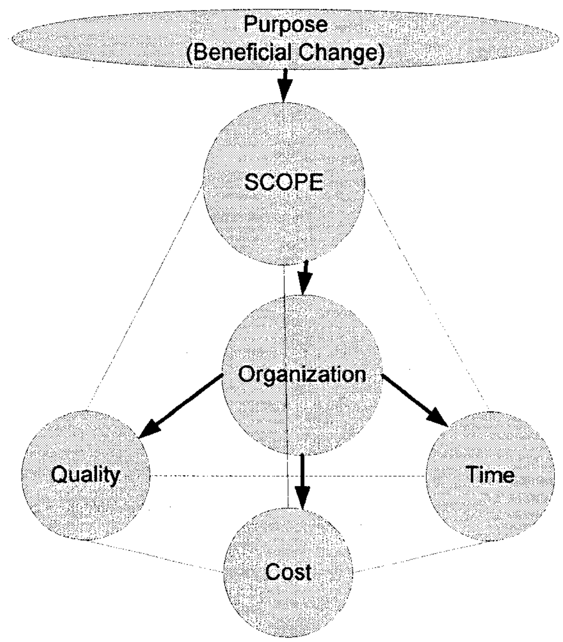

Figure 2.11: The five project objectives (Turner, 1993)

1. Scope

Scope can be defined as the "sum of products, services, and results to be provided as a project" (PMBOK, 2004). Project scope is the work that must be done to deliver the scope (product, service, or result with the specified features and functions (PMBOK, 2004). Turner (1993:101) stresses that scope management is to "ensure that enough, but only enough, work is undertaken to deliver the project's purpose successfully."

The outcome of a project can be a product with particular specifications or a service. In the case of large integrated solutions, scope is represented in the solution's architectural documentation. This covers the following: summary of the business need, descriptions of new functionalities or use cases, architectural diagrams (hardware, software, networks, communication etc.), testing and implementation strategies, high level effort estimates, targeted system performance, technology choices and software versions etc.

This document is usually the project blueprint and is approved by the client. All partners that will collaborate to implement the new solution refer to this architecture when they draft their contract. Should any conflict arise during the project execution, the project team can go back to this document. That's why it's important that the target architecture or design be well documented to avoid potential conflicts.

Some major projects are confronted with a time constraint which forces the execution phase to start before the architectural phase is completed. This is equivalent to launching a project with a half defined scope. It requires special organizational capabilities and expert resources to deal with a highly dynamic environment. An example is a bank that has to abide with a new regulation by a certain date. Such a bank might not have enough time to complete the architectural phase before starting to execute the project. As a result these two phases will overlap in order to meet the target date.

PMI places scope at the centre of Time, Cost and Quality as seen in Figure 2.12. This stresses the interdependence of these elements.

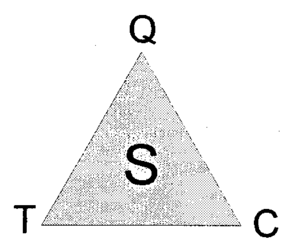

Figure 2.12: Project Scope

Variations in the product or solution design are examples of changes in scope. For IT solutions, changes should be reflected in the architectural documentation. Hence a change in any of the technical diagrams and functional specifications is accompanied by a change in the project scope. Some examples are:

To use a different database or a different third party software provider: switching from a Structured Query language (SQL) to an Oracle database because of some performance issues discovered during the testing phase

To upgrade to a later software version: moving to Web Sphere Application Server (WAS) version 6 instead of version 4 because the current version is not supported anymore.

To use a different or newer security standard that got imposed on the corporate level: using Secured File Transfer Protocol (SFTP) instead or File Transfer Protocol (FTP).

To introduce a new functionality that reflects a new business need: a financial institution that launches a new credit card can force changes to a system that is in an execution or a testing phase.

To apply a new patch or fix to reflect a new regulation: apply the Daylight Saving Time (DST) patch which had to be reinforced on a fixed date while some projects were close to completion.

2) Organization

The organization consists of all the resources that are put together to undertake a given project. Turner specifies that the project organization's purpose is "to marshal adequate resources (human, material and financial) of an appropriate type to undertake the work of the project, so as to deliver its objectives successfully" (Turner, 1993:135). He mentions 3 main activities that are part of managing the project organization:

Negotiate a contract with each partner involved in the project

Determine roles and responsibilities at levels of the work breakdown structure

Adopt a clear reporting structure

In the following we see some examples of changes in the project organization. A client can switch from a time and material cost contract to a fixed cost contract after the project has already started. This could be motivated by a new risk assessment where the client prefers to transfer part of the risk to its partners. The role of project integration can be contracted to one of the partners or assumed by the client. Actual examples of such changes will be detailed under the data analysis presented later in Chapter_4. This decision can arise after the project has already begun and when client lacks the expertise to integrate a particular project phase. Such role can also shift from a partner to another during the project lifecycle.

3) Quality

The quality has always been a factor difficult to measure as compared to cost and time. For this we need to understand what quality means in the context of a project. PMI defines quality as "the degree to which a set of inherent characteristics fulfills requirements." This implies that a substantial effort is required from the client in early stages of the solution lifecycle in order to define all requirements or specifications in the 'business requirement' document. Some examples of such requirements are the following:

A financial institution that wants to upgrade its infrastructure to support a large clientele and hence more transactions per second. This institution should perform a market analysis to determine the potential number of transactions that it will have to process on a short, medium and long term basis.

A call center that wants to reduce the average number of mouse clicks that an operator has to perform before answering client's question. An example could also be the time a customer waits on the phone before reaching an operator.

In addition to meeting client requirements, Turner (1993) mentions two more elements within Quality. These are: 1) 'good quality' vs 'high quality' and 2) fitness for purpose. In the first case, the project should not aim at implementing high quality if good quality is sufficient. For example, choosing an office printer for daily use by all employees of the department need not produce top quality printings. A good quality print out is sufficient because the printed documents are only intended for internal short time use. The second factor is related to the first where fitness for purpose is often used to measure good quality (Juran, 1974). In the previous case a printer can be considered of good quality if it is power efficient and has low ink consumption.

Quality methodologies

One of the most widely used processes for implementing quality in the manufacturing and services industries, is the Total Quality Management (TQM). This is defined by the International Organization for Standardization (ISO) as: "a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society". The TQM process contains five main elements which are: 1) quality of the product, 2) quality of the management processes, 3) quality assurance, 4) quality control and 5) the attitude of mind. Among the gurus of quality we find:

- Constancy of purpose (Deming, 1986)
- Management of the vital few (Juran, 1974)
- Zero defects (Crosby, 1979)

Fish bone diagram (Ishikawa and Loftus, 1990)

The Capability Maturity Model (CMM) developed by the Software Engineering Institute[19], is also widely used by the IT services industry as an indicator of the quality on the process level. CMM is composed of five maturity levels which are: 1) Initial, 2) Repeatable, 3) Defined, 4) Quantitavely Managed and 5) Optimizing. Some clients require that their partners be CMM 5 certified. One of the reasons many clients are outsourcing to India is because large IT Indian firms are CMM 5 certified.

4) Cost

PMI defines cost as "the monetary value or price of project activity or component that includes the monetary worth of the resources required to perform and complete the activity or component or to produce the component." Project Cost is usually composed of labor hours or material cost such as hardware or software. Cost can be direct such as a new server dedicated to the project's solution or indirect such as overhead facilities. Another dimension to cost is variable vs. fixed. The first varies in function of time,

[19] http://www.sei.cmu.edu/

effort or work, while the second consists of a predetermined price that is independent of the effort or time required to perform the activity.

The main indicator used to track a project cost performance is the Cost Performance Index (CPI). CPI measures the cost efficiency of a project. It compares the actual cost and newly estimated total project cost to the initially planned cost. A deviation of the CPI below or above the value 1 means that the project will respectively cost less or more than the planned budget. A detailed explanation of CPI and earned value calculations is presented in Appendix D. A CPI that is less than one can be due to several reasons such as wrong estimates, rework or bad planning. In some projects we notice that CPI drifts below 1 because of scope changes. This should not be the case because whenever there is a scope change that has an impact on cost or time, the project baseline should be reviewed. This means that activities which are added to the project following a scope change should be baselined and reflected in the denominator of the CPI. Only newly added/removed activities should be baselined and not the entire project. Thus CPI should not be reset to 1 after a scope change.

Some of the most widely used tools to track project cost performance are: Ms Project, Primavera etc.

5) Time

Turner (1993:206) defines the time schedule as "a series of dates against the work elements in the work breakdown structure, which will record our forecast of when the work will occur and when the work actually does occur." Time usually is an important indicator of project success. Integrated solution's implementation dates are visible to all the organization. Senior managers track these dates which give them a high visibility. Furthermore, the implementation date of a particular module should be carefully coordinated with other projects that might use some common infrastructures. The time indicator becomes even more important when the project is driven by an external environment such as a new regulation. The firm has to meet an established date for a new regulation in order to avoid any penalty. This could have a direct impact on the business and the performance of the whole organization. Meeting the Basel II accord requirement by a given date is very important for financial institutions that compete on the national and international levels.

The main indicator used to track a project time performance is the Schedule Performance Index (SPI). SPI measures the project advancement across time. It shows if the project is late on schedule and hence might miss the targeted date. This usually prompts corrective actions by the project manager. He can add resources or ask for overtime or even fast track some activities. Project managers pay close attention to the critical path when studying the project schedule. The critical path represents the sequence of activities with the longest elapse time. This usually determines the total project time.

A detailed explanation of SPI and earned value calculations is presented in Appendix D. An SPI that is less than one means that some activities are late and the project might not meet the target implementation date.

In some projects we notice that SPI drifts below 1 because of scope changes. This could also lead to a new implementation date. Hence when scope changes are not reflected in the project baseline, the SPI will show a red flag. This situation does not mean the project has a bad performance or is mismanaged. It is important to understand what the reason of time delay is. This can often be traced back to a scope change. Therefore, whenever there is a scope change that has an impact on cost or time, the project baseline should be reviewed. This means the activities that are added to the project following a scope change should be baselined and reflected in the denominator of the SPI. Conversely, only newly added/removed activities should be baselined and not the entire project. Thus scope change should not be a reason to readjust the SPI to 1.

2.IV.B. Success indicators

Below I will review the most common success indicators documented in the literature when implementing an integrated solution.

"Implementation success is frequently defined in terms of the achievement of some predetermined goals, which normally include multiple parameters such as time, cost, functionality/quality" (Hong and Kim, 2002). An ERP implementation success can be measured in terms of the perceived deviation from the expected project goals such as cost overrun, schedule overrun, system performance deficit, and failure to achieve the expected benefits (Hong and Kim, 2002). Literature doesn't account for scope changes when measuring the success of a project. We can see the Time, Cost and Quality elements mentioned and measured without taking into account changes in scope which can have a direct impact on the remaining project definition elements.

We mentioned previously that Zhang et al (2005) refer to a recent Standish Group report on ERP implementations which reveals that these projects were, on average, 178% over budget, took 2.5 times as long as intended and delivered only 30% of promised benefits. Despite these figures and even if ERP system implementation exceeds contracted delivery time and budget; many firms still consider their ERP implementation a success. Zhang et al (2005) stress that "[...] only user satisfaction, intended business performance improvements, and predetermined corporate goals could be used as success measures".

Such reports do not take into account the scope evolution which gets reflected on the Time and Cost factors. In other words, the cost and time deviations refer to the primary project definition which corresponds to the initial scope definition. The latter has evolved throughout the project lifecycle and should be reflected on the Time and Cost baselines.

Zhang et al (2005), who were inspired by the dependent variables of the Delone and McLean model, identified seven indicators to measure the implementation success of an

ERP: 1) user satisfaction, 2) intended business performance improvements, 3) Oliver White's ABCD[20], 4) on time, 5) within budget, 6) system acceptance and usage and 7) predetermined corporate goals.

User satisfaction: In their framework of MRP success measures, Ang et al (2002), used the degree of satisfaction as a major indicator. The reasons given by interviewees for their high degree of satisfaction were: 1) the system had forced all areas to follow procedures, 2) The people had maintained high discipline, 3) The people were using the system very well, 4) the way MRP was being used made the planner's job much easier, 5) the computerized modules were fully integrated, 6) the inventory accuracy was over 99%, they were consistently able to meet 89% on-time delivery.

According to Delone and McLean (1992b) user satisfaction describes the receipt response to the use of the product of an IS. While user satisfaction might be the ultimate indicator of an ERP implementation success, we shouldn't forget that system quality and information quality are key factors that drive this end-user satisfaction.

Zhang et al used the individual impact as a replacement to the user satisfaction indicator. Individual impact is adapted as the effect of the implementation and use of an ERP system on the behavior of a receipt or IS user. The dimensions used to measure individual impact include: 1) improved individual productivity, 2) task performance improvement, 3) decision effectiveness and quality, and 4) time to make decision.

Intended Business Performance Improvements: New IS adopters set performance objectives of the projects which include cost reduction, business processes integration, time response improvement (Zhang et al., 2005). Since several measures are used to determine if a system implementation is a success or not, only when all four measures are answered positively by a firm can we consider the implementation a success. And only when all four measures are considered negative would the implementation be

[20] The ABCD Checklist aims at determining the degree of success of the implementation of an IS. For more information about Oliver White Checklist: http://www.bpic.co.uk/abcdlist.htm

considered a failure. Oliver White's companies developed an ABCD check list in order to determine if an integrated system implementation is successful. The list is illustrated in appendix C. Similar check lists have been used by a few authors when studying IS implementation success (Wilson et al., 1994, Zhang et al., 2003).

On Time: The time indicator is one of the main indicators of every project implementation. The Schedule Performance Index (SPI) is used by the PMI as an indicator to track the evolution of the project (PMBOK, 2004). This indicator helps top management, when performing periodic project reviews, determine the status of their project and take appropriate actions to realign the project.

Within Budget: The cost indicator is another major indicator for every project implementation. PMI uses the Cost Performance Index (CPI) as an indicator of the project performance from a budget point of view (PMBOK, 2004).

System Acceptance and Usage: In their framework of MRP success measures, Ang et al (2002), evaluated the ERP success based on the system acceptance and usage. The reasons for high degree of satisfaction were: 1) system was working well, 2) people were using the system well (They knew how to work with and make use of the system), 3) people were optimistic that they would enjoy more benefits in the future, 4) system was fulfilling their needs, 5) all modules were integrated and used.

Predetermined Corporate Goals: Zhang et al (2003) used the organizational impact indicator that accounts for corporate goals as one of the success indicators. Organizational impact includes: 1) impacts of the IS implementation and the use of the organization's operating cost, 2) overall productivity gains, 3) customer service level and the realization of specific IS implementation objectives.

Table 2.4: Summary of the most common success indicators found in literature

Success indicators	(Ives et al., 1980)	(Delone and McLean. 1992a)	(Wilson et al., 1994)	(Ang et al., 2002)	(Hong and Kim, 2002)	(Motwani et al., 2002)	(Mandal and Gunasekaran,	(Al-Mashari et al., 2003b)	(Mabert et al., 2003)	(Umble et al., 2003)	(Xue et al., 2005)	(Zhang et al., 2005)	(Yusuf et al., 2004)	(Ehie and Madsen, 2005)
User Satisfaction	X	X		X				X			X	X	X	
Intended Bus. Perf Improvement	X	X			X		X	X			X	X	X	X
White's ABCD classifcation			X									X		
On time					X			X	X					
Within Budget					X			X	X					
System acceptance and usage	X	X		X										
Predetermined corporate goals	X						X			X	X	X	X	

From the previous table, we can note that Time and Cost were not very popular success indicators. This could be for several reasons. First, the nature of these implementations was not Time critical. The new solution or system was not imposed by an external regulatory body and did not have to be implemented before a target date. Secondly, there was a large divergence between the client's required scope and the IT firm's perceived scope. On the one hand, clients didn't have enough IT expertise and were not used to implementing such large systems. On the other hand IT firms lacked some industry expertise. This often lead to divergence between the client required scope and the IT perceived scope. Thus meeting the intended scope and business performance improvement was the most important factor. Finally, measuring project success based on time and cost factors became less relevant when scope changes were not reflected in these elements' baseline.

Other changes to the project definition can come from the organizational element which usually impacts Time, Cost and Quality. In the context of an open innovation environment, multiple players have to collaborate and work together in order to implement one system. These partners engage in long term alliances with one common client. New alliances can be formed based on the episode of the solution lifecycle. Different contractual engagements may be required for different episodes based on the client expertise and the risk factor. Furthermore different consultants' characteristics and capabilities are required for each episode. This can bring changes to the project Organization which can have an impact on three other factors namely quality, cost and time.

The five elements of the project definition mentioned above will be part of this research conceptual model and constitute the dependent variables which are: 1) Scope, 2) Organization, 3) Quality, 4) Cost and 5) Time. A particular attention will be on the scope element and its evolution during a solution's lifecycle. This has hardly been studied by previous researchers. Project performance can not be evaluated only by studying the time and cost factors without taking into account the scope evolution as well as the project organizational changes.

2.V. Risks, Contracts and Options

The previous literature hardly acknowledges changes to the main elements of the project definition mainly scope. The latter can have a direct impact on the remaining elements and hence time and cost baselines should be reviewed if they are to be used to measure project performance. Some researchers point out that innovative projects are subject to changes in their scope and try to address this in the front end of the project. Projects face multiple risks that are related to the nature of the solution to be implemented. Risks can be of different nature such as technical, market or institutional. Such risks can be addressed or mitigated through different types of contractual agreements. Another way to deal with a high uncertainty factor related to a project is to use a real option's approach where a manager can delay and wait for more information before investing in the entire project. Hence different contractual agreements and real options approaches recognize potential scope changes and try to address it in the front end phase of a solution's implementation.

This section will explore the different types of risks and approaches to manage innovative integrated systems. This will be followed by an examination of the different types of contracts that can be used depending on the context of a specific project. The real option's approach will also be considered for dealing with risk and uncertainty related to the project definition elements as well as optimizing contracts.

2.V.A. Risks

Three classes of risks can be associated with projects (Miller and Lessard, 2007). They are 1) technical and operational risks, 2) market risks and 3) institutional-social risks. The following will address these three different classes of risks from an MIS project point of view.

Technical and operational risks: An MIS solution faces technical uncertainties in different phases of its implementation. A new design resulting from an architecture phase can account for several risks. For example the minimal number of transactions per second required in the business model may not be reached when assembling all the solution. This can be often addressed by building prototypes in order to simulate the future system. Some technologies or software versions may not be compatible with the rest of the system. Operational risks are related to the project execution process. An example is key resources that get exhausted because they worked long hours on a major technical issue. Another example is the orchestration of multiple partners that have interdependent tasks and activities.

Market risks: they are related to demand and supply. In the case of demand, some clients find it difficult to forecast a proper customer demand. An example is when a bank that cannot accurately predict the number of customers accessing its transactional portal five years down the road. Large firms address these issues buy building flexible and dynamic architectures that can easily extend the systems capacity. Supply risk is related to the equipments (hardware and software) required for the project team to implement the solution. Suppliers try to reduce their costs by reducing their inventory. Ordering a server
from IBM requires on average two months. Furthermore when implementing a new system, several modules developed by third party providers need to be upgraded. The project team will be dependent on such providers in order to advance in the implementation and testing processes.

Institutional-social risks: they can be the result of new regulations or of social or user responses to the particular project. New regulations are continuously issues by governments. In the last decade many security regulations had major impact on financial institutions. Examples are the Basel II accord and Sarbanes Oxley Act. Another example is the Energy Policy act[21] signed in the USA in 2005 and which is enforced in the mars

[21] The **Energy Policy Act of 2005** (Pub.L. 109-58) is a statute that was passed by the United States Congress on July 29, 2005 and signed into law by President George W. Bush on August 8, 2005 at Sandia

2007. This act advances the daylight saving time in North America forcing all financial institutions to bring changes to all their systems and servers. User response risk is related to the reaction of the end user to the new system.

Most of the above mentioned risks surface over time. They can also be associated with the lifecycle of the project. Design and technical risks diminish when the project enters the testing phases and as it approaches the implementation date.

Contract types can sometimes be used as a way to manage risk. This will be discussed in the following.

2.V.B. Contractual Relationships

A client engages in contractual relations with several consulting firms in order to create a cooperative and 'shared' organizational design, in which all parties are motivated to achieve a common objective (Levitt and March, 1995) . Different contracts can be used depending on the 1) uncertainty in the project's deliverables and the 2) uncertainty in the process of their delivery (Turner and Simister, 2001). In the case of the Betuwerout project (Turner and Simister, 2001) the contract type's selection also conformed to the following parameters: 1) the complexity of the situation and 2) the ability of the client to contribute to the resolution of a problem. IT projects which were not researched by Turner et al were classified under the following parameters:

High uncertainty of the product and high ability of the client to contribute to the project

Low uncertainty of the process and low complexity of the situation

Although this classification is generally acceptable it cannot be generalized in all IT projects.

National Laboratories in Albuquerque, New Mexico. The Act, described by proponents as an attempt to combat growing energy problems, provides tax incentives and loan guarantees for energy production of various types.

Below, is presented the main contract types that can be engaged between two parties. The PMBOK (2004) classifies contracts under the following three main groups: 1) fixed price contract, 2) cost reimbursement or time and material contract and 3) cost plus contract.

Fixed Price or lump sum contract: in the case of a fixed price contract the client will pay the contracting or consulting firm a predetermined price once the work has been completed. Payments can also be spread and prorated over the duration of the project based on the activities or deliverables achieved. In such a contract type, the client has to clearly define the final product or solution he wants to have. Once the contract is signed, the consulting firm will be motivated to achieve the contract within the established budget. If the work was overestimated and/or the consulting firm was very efficient, the contractor will benefit. In the case where the amount of work was underestimated and/or the contractor was inefficient, the consulting firm will have to reduce its profit margin or even lose money. Subsequently, the consulting firm will try its best to improve its efficiency, without compromising the quality, in order to optimize its profit margin. The maximum profit a contractor can have is limited by the total contract price. In such a contract type, most of the risk is assumed by the contractor.

Cost-reimbursable contracts: in the case of a cost-reimbursable contract, the consulting firm is reimbursed its actual cost plus a predefined fee that represents its profit. Two types of costs can be distinguished: direct costs and indirect costs. The direct costs are all expenses directly and exclusively related to the project. This includes salaries of full-time project staff, equipment and materials purchased exclusively for the project that won't be used once the project is completed. Indirect costs are usually considered as overhead costs or administrative costs. The latter costs cover a percentage of the salaries of management involved in the project and a percentage of the office space and equipment used and shared with the rest of the organization. A cost-reimbursable contract often includes an incentive clause which encourages the consulting firm to meet or exceed the project objectives. Three types of cost-reimbursement contracts can be considered:

Cost plus percentage of cost: The incentive fee can be calculated as a percentage of the total cost of the project. The fee varies with the actual cost of the project.

Cost plus fixed fee: the contractor receives a fixed fee calculated as a percentage of the estimated project cost. The fee is fixed and is not based on the actual project cost. The fee can change when the scope changes.

Cost plus incentive fee: this is a combination of the previous two fee types. On top of covering the cost, the client pays the consulting firm a predetermined fee and an incentive bonus based on achieving the project objectives.

Time and material contracts: time and material contracts are a combination of fixed price and cost-reimbursement contracts. On the one hand, the client reimburses the contractor based on a preset unit rate. The rate is fixed and agreed upon in the contractual agreement. On the other hand the number of units is not preset. Three different types of unit rates:

Schedule of rates: this could be represented by the hours a consultant works on a project. The client pays the consultant based on an agreed dollar amount per hour.

Bill of quantities rate: the client pays a standard rate per report or function developed or programmed.

Bill of material rate: the client pays a standard rate per computer mounted or assembled.

Different types of contracts can be used in different phases and with different partners when implementing a solution. This can be influenced by the technological uncertainty of the product or solution. Clients can engage in a purely technical project such as a major infrastructure update, or the introduction of a new technology. In such a case, clients have neither enough expertise nor much control over the risk involved. Thus, they tend to transfer the risk to the contractor by using the fixed price type. On the other hand, when the client acts as a subject matter expert or when the project is more about functional changes within a known technology, contracts tend to fall into the Time and Material category. Consequently, the risk is shared among different players. The client feels comfortable to challenge and to act as the project integrator.

2.V.C. Real Options

Some clients prefer to use a real option's approach during different phases of the solution lifecycle. The term 'real option' was initially used in 1977 by Stewart C. Myers of Massachusetts Institute of Technology (Myers, 1977) who observed that the cash flows of many investments consist of income from the assets in their current use, plus a growth option to expand into new markets in the future. Its first applications was in gas, oil, copper and gold companies. Later other types were identified (Trigeorgis, 1996) such as wait option, abandon option, input, output change option etc.

Real options can be grouped into two main categories (Jacquet, 2001): Process Optimization Real Options (PORO) and Growth Opportunities Real Options (GORO). The PORO deals with markets where the Input and Output are well defined. The uncertainty is related to volumes, price, locations, and duration. The firm should focus its resource allocation process around these uncertainties and invest in flexibility. The GORO as opposed to the previous one deals with growth. For a company to grow and prosper, it needs to invest in the long term. So the company should continuously be reinvented and new development opportunities should be identified and considered. Hence the company invests in incorporeal assets (competencies, know-how, software, soft skills) and corporeal assets (infrastructure and logistics) in order to be better positioned to capture value.

Real option thinking is important to consider for solutions and product strategy. When a company is determining its long term strategy and which system or technology to invest in, a range of likely outcomes can be determined and the real options approach can be used. Leading companies use real options to manage the staging, gating and scaling of cash flow decisions in the innovation process.

Real Options vs project: A project is a temporary endeavour undertaken to create a unique product or service. The project is composed of several stages that are usually performed in sequence. An important element of a project is "Project Review" that can occur within a stage (phase) and at the end of each phase. So the implementation of a new solution can be seen as a series of project phases separated by project reviews. A project review constitutes the GO/STOP action leading to the next stage or abandoning the project. Hence innovative projects can be treated as a series of real options linked by a temporary sequence of decisions. The project process uses options of type PORO. This process helps create or build an asset of GORO type when it comes to the development of new solutions.

***Real option vs Net Present Value (NPV)*:** The NPV calculations consider the innovation as static; whereas real options take into account its inherently dynamic nature. They provide a way to fold into the decision process two sources of earning, the first involving learning by doing and the other involving learning while waiting. At each stage of scaling or exiting the project (option), both sources of information come into play. By using options, one moves from considering innovation as making a bet to considering it as buying a possibility for the future.

Real options vs uncertainty: 'One key insight generated in the real options approach to investment is that higher uncertainty in the payoffs of the investment increases the value of managerial flexibility or the value of the real option' (Dixit and Pindyck, 1994). The types of uncertainties are summarized in the following:

- Market Payoff: the market payoff (price and sales forecast) depends on uncontrollable factors such as competitor moves, demographic changes, substitute products etc. It therefore has a significant random component.

- Project Budgets: refer to the fact that the running development costs of the project are not entirely foreseeable. Budget overruns are common, and less frequent. Under budget completion also occurs.
- Product Performance: corresponds to the uncertainty in the performance of the product being developed. The greater the technical novelty of a product, the higher uncertainty.
- Market requirements: corresponds to the uncertainty about the performance level required by the market.
- Project schedules: The project may finish unpredictably ahead of or behind schedule.

Real options can be, on one hand, applied to one solution where a client wants to know the best prototype to use and best consulting firm to hire. Hence clients can engage more than one consulting firm to work on a prototype before selecting the best solution as well as the contractor. On the other hand, real option can also be applied to a portfolio of projects where a client engages in several architectural studies for different solutions. At the end of the architectural phase the client chooses which solution(s) has more potential and a better strategic advantage.

2.V.D. Conclusion

In summary in this section we presented different approaches to manage innovative integrated systems in the front-end phase. We covered 1) the risks that an innovative solution, involving many partners, faces, 2) the different contractual relationships that can be used based on the uncertainty factors and 3) the real option's approach. The above mentioned approaches don't account for changes in the project definition elements and scope throughout the project's implementation cycle. Such approaches only recognize and deal with changes to the project definition and scope only in the front end of the solution's lifecycle. In our exploratory study we noticed that changes to all elements of the project definition occur at multiple stages of the solution's implementation lifecycle. Such changes will be the focus of our research in the subsequent phases.

CHAPTER 3: Research Structure and Methodology

3.I. Research Structure and phases

This research was conducted in five phases that spanned over 3 years. The approach is inspired by the grounded theory where theory is built from qualitative data then validated again through a field study (Glaser and Strauss, 1967). Below is a recapitulation of the main five phases of this research and the process that lead to generating and validating the conceptual model. The five phases are:

- Exploratory research to understand the SCE dynamics and the player's characteristics,
- Exploratory research to understand large IT solutions and their corresponding ecosystem,
- Qualitative analysis of large proprietary projects and generation of conceptual model,
- Detailed analysis of changes and evolution of project definition and scope within five (5) large innovative proprietary IT projects undertaken by major financial institutions. Three projects were selected as highly innovative and two as medium to low innovative,
- Exploration of the different solutions and approaches used by SCE firms and clients to address the project definition and scope evolutions.

3.I.A. Phase I: SCE GAME

The aim of the first phase was to understand the dynamics of innovation in the SCE Game as well as the characteristics and roles of the players involved. A series of case studies was conducted in Europe and the Middle East with multiple consulting firms that belonged to this Game. Twelve (12) senior managers from seven (7) top consulting firms were interviewed for a period of 1 to 2 hours. Additional documentation was gathered from consulting firm's websites, specialized websites, books, articles and white papers.

Four types of players were identified: the strategist, the architect, the solution or project manager and the operator. Each player has different capabilities and characteristics and plays a different and complementary role in the solution's lifecycle (Nehme et al, 2006). This was addressed in the System Integration section (Chapter_2_I).
Consequently, this first phase led us to understand that innovation in this game is mainly achieved through projects, where different complementary/competing partners collaborate in order to achieve a common client's objective. Not surprisingly, IBM's slogan in London's international airport was "innovation in collaboration" (ref). We decided to focus in phase II on major IT solutions undertaken by large clients in collaboration with multiple SCE partners.

3.I.B. Phase II: Large IT Solutions

In the second phase we concentrated on large innovative projects undertaken by one major client. These projects involved multiple stakeholders such as system integrators, software/hardware providers, customer Business Units, regulators etc. All partners had to collaborate in order to achieve one common project objective. Ten (10) IT related projects, from five different industries, were studied in North America. These projects covered the implementation or development of a major IT solution and/or the migration or installation of new technological infrastructures.
For each project, multiple interviews were scheduled with senior managers from the client side as well as from each major partner involved in the solution's lifecycle. A total of twenty three (23) senior managers were interviewed for a period of one to two hours. Furthermore, large documentation was collected for each project. This covered internal

documents that the firms accepted to share with us, and public information gathered from websites and white papers. In some cases, the process of gathering information was extended to emails and phone calls to ask for further clarification.

This phase helped us understand how large clients engage in long term partnerships with SCE firms for the selection, development, implementation, operation and evolution of convoluted IT solutions.

Two different types of projects were differentiated depending on the maturity of the solution to be implemented: 1) Mature Systems or Solutions such as an ERP or an MRP, 2) Growing Systems such as a PLM. This is detailed in the Integrated Systems' section. The degree and dynamics of innovation is different in these two systems. The implementation of mature systems/solutions which were already implemented at several clients' sites was the least innovative. These systems had already developed all their modules and functionalities which were tested on several sites. The implementation process is well known and it tends to follow the linear or cascade model.

On the other hand, growing systems are more innovative. They are still developing new modules and functionalities and the implementation process is more challenging. A third group of systems was also identified in this phase which is the 3) proprietary or custom projects. This last group is studied in phase III.

3.I.C. Phase III: Proprietary Solutions

In this third phase we selected five large IT solutions or projects undertaken by large financial institutions in Canada. This last group of projects namely the custom or proprietary systems were the most challenging ones. Such systems are unique to one client. The project team can hardly capitalize on a similar previous implementation done inside or outside the client's premises. We selected three projects that were highly innovative and two that were classified by the financial institutions as having a medium to low innovation degree. The studied projects are the following:

- Internet Infrastructure Revamp (IIR) - technological and business driven project classified as highly innovative,
- Check Imaging (CI) - regulation driven project - classified as highly innovative,
- Basel Accord II (BIIA) - regulation driven project - classified as highly innovative,
- Intranet Infrastructure Migration (IIM) - Technological and business driven project - classified as medium innovative,
- Application Revamp (AR) - business driven - classified as medium/low innovative.

The above mentioned projects will be explained and introduced at the end of this section.

Throughout the interviews and analysis of Phases II and III we noticed that project definition and scope evolve during the solution's lifecycle. Literature hardly addresses dynamic project definition and evolving scope. Most literature acknowledges the time and schedule evolution but doesn't address scope evolution which often drives the remaining project elements and requires a new baseline for time and cost. Some literature addressed project definition changes only in the front end of the solution's implementation phase and not throughout this last phase. This led us to focus our research on changes that occur all through the implementation of a solution. This will be the subject of the fourth phase.

The three major financial institutions covered in this research will be identified as A-bank, B-bank and C-bank. For reasons of confidentiality, no name or specific financial or technological data will be presented in this research.

At the end of the third phase, we developed a conceptual model where we identified, based on the projects studied, two groups of elements that contribute to an evolutionary scope and hence a dynamic project definition. These two groups are 'Multiple

Influences' and 'Emergent Uncertainties'. This will be explained and developed in the second part of this section. Finally, we identified the change request as the unit of analysis which is to link the independent and dependent variables.

3.I.D. Phase IV: Detailed analysis of Change

The fourth phase consisted of a 1) detailed study of each of the five proprietary integrated solutions and 2) a detailed analysis of more than 500 change requests that were issued for these projects.

A large documentation of the proprietary projects was gathered and analyzed. In the case of regulatory projects, new regulations and laws were reviewed. The Evolution of the regulations in parallel to the project execution was also analyzed. Moreover, multiple articles and presentations were reviewed to complement each case study.

In the case of new infrastructural projects and new solutions, the raison d'être of the project was examined. Other project documentation such as organizational charts, meeting minutes, project management plans etc. were gathered and analyzed.

Also, more than 500 change requests were analyzed in detail and classified. Each change request was mapped to the conceptual model. The elements that initiated the CR were mapped to the independent variables and the impacts of each change request were linked to the dependent variables. The conceptual model was reviewed and fine tuned as we progressed through the CR codification and analysis. After every iteration of the conceptual model, previously analysed CR were revisited to confirm the codification. Several adjustments to the conceptual model were required after each iteration. A total of five (5) iterations were performed throughout this research. The iterative process and methodology used for this research is similar to the unfolding phase of innovative projects. The conceptual model (architecture or design) is reviewed throughout the change requests codification (implementation phase composed of development and testing).

3.I.E. Phase V: Approaches to face an evolving scope

The last phase's objective was to understand how clients and SCE firms face an evolving scope and what approaches are put in place to avoid or deal with major project redefinitions. In the case of the client, we reviewed the project structures put in place by the five programs mentioned above. In order to understand the SCE firms' approach to an evolving scope, a series of case studies were conducted with seven (7) top Indian system integration firms that work with large financial institutions in North America and Europe. Twenty one (21) senior managers were interviewed for a period of one to two hours each. This led to six main approaches used by clients and SCEs to address and handle a dynamic project definition. These approaches can be grouped into three categories: 1) the front end of the project or pre-initiation, 2) the unfolding of the project or post-initiation and 3) the global approach.

Some SCE firms in collaboration with clients, in the front end category, build an Ecosystem composed of all parties involved in the solution to validate the project definition which includes scope, organization, time, quality and cost. This validation phase takes place before the project kick off and is considered by several SCEs and clients an investment that is worth having. The second alternative adopts the Real Option's approach. In this case clients engage in minimal investments in minor initiatives or pilot projects. Based on the outcome of these initiatives and the new market data that becomes available clients decide to commit to the best alternative. In other words, clients try to avoid a major commitment at an early stage. They launch several small initiatives and try to study several alternatives which give them more options and time to decide.

In the second category, two main approaches were observed in the project structure and methodology: 1) Design committee and 2) Global Calendar. Some clients added to their organizational structure a committee responsible for scope management. This committee mainly composed of senior architects is responsible for issuing scope changes. The committee is also in charge of validating the CRs received by the partners and determining if they are related to scope changes or not. This avoids scope creep (uncontrolled changes in a project's scope which could result in overrun of project cost and schedule). This phenomenon can occur when the scope of a project is not properly defined, documented, or controlled.

The second approach is to construct and maintain a global calendar that represents multiple phases of solutions impacted by the given program. Several solutions that share a common infrastructure have to be coordinated in order to avoid conflicts. A change in the schedule of any solution potentially impacts the timeline of another solution. It follows that a global calendar and project plans must be dynamically updated accordingly.

The third category is the global approach which is comprised of 1) Agile strategy and 2) long term partnership. The Agile strategy consists of adopting a dynamic methodology which adapts to an evolving scope such as 'Agile' programming. Such methodologies embrace and endorse evolutional change across the solution's lifecycle. Highsmith and Cockburn (2001) state that "Adaptive Software Development [...] view change from a perspective that mirrors today's turbulent business and technology environment." This approach can be extended to the enterprise. This is usually known as the Agile enterprise.

The second approach consists of a long term partnership, which goes beyond a simple outsourcing agreement, between a client and the system integrator. The SCE firms can be called upon to develop business expertise and provide business solutions in addition to technical expertise.

3.II. Observation

As a summary of the literature review we observed that:

- Success for most IT projects tends to be measured or determined based on the initial objective and initial scope.
- It is hard to predict the exact performance of an innovative IT proprietary solution or infrastructure despite pilot projects.
- Large IT proprietary projects coexist and share common resources along with operational and evolutionary projects
- Large proprietary IT projects require a client to work and collaborate with large specialized partners.
- Previous literature neither accounts for a scope evolution and nor for scope management across the project lifecycle.
- Some researchers account for changes to the scope evolution but only address it in the front end phase of the project.

3.III. Research objective and hypotheses:

In the exploratory study (phases I and II) described above, it was noticed that project definition and scope evolve during a solution's lifecycle. This is particularly relevant for large innovative complex IT proprietary solutions. Furthermore, firms use different project structures to deal with scope management.

This research aims at understanding how project definition which is composed of five main elements (scope, organization, quality, cost and time) evolves through the implementation lifecycle of a large strategic proprietary complex innovative IT solution. A particular stress is put on the scope element which has rarely been studied in the past. It's important to focus on scope because it usually drives the remaining secondary elements (Turner 1993).

Therefore, this research will study the elements that lead to project redefinitions and require scope management in large proprietary innovative IT solutions. Two sets of elements were identified based on the detailed case studies of five proprietary projects undertaken by financial institutions. These categories are: Multiple Influences and Emergent Uncertainties as illustrated in Figure 3.1. The Multiple Influences elements are Exogenous to the project boundaries while the Emergent Influences come from within the project and solution itself.

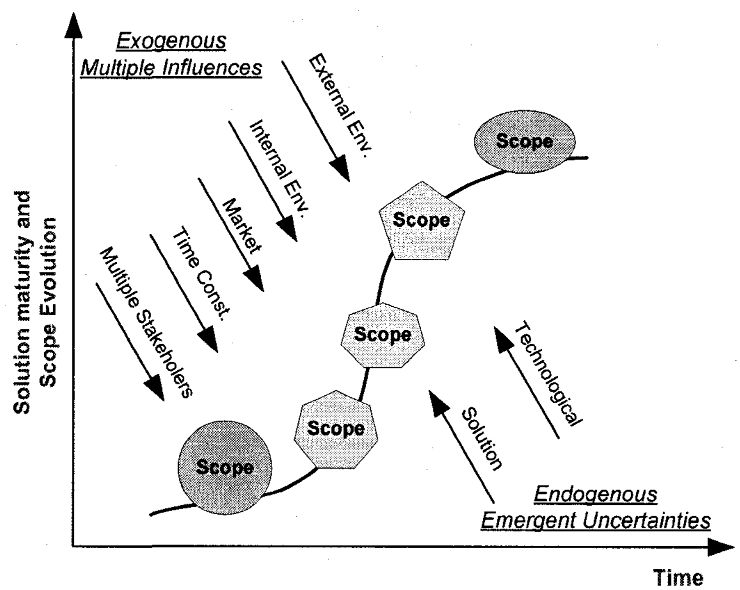

Figure 3.1: Scope evolution based on Exogenous and Endogenous changes

Based on these observations, we can derive three main hypotheses for this research which apply to large strategic innovative complex proprietary IT solutions:

H1: Changes to the project definition and project scope occur all through the implementation lifecycle of an innovative project.

Most researchers tend to follow a linear or cascade project approach to managing large innovative IT solutions. This presumes that the project scope is frozen at the end of the Design phase and remains stable all through the solution's implementation lifecycle. In our research we observe that the Design phase is often extended and can run in parallel to the implementation phase. This allows the project scope and definition to adapt and evolve according to new data and information that become available throughout the implementation phase

Changes to project definition and scope are not only limited to the front end phase but also all through the implementation lifecycle.

Scope is the main element of a project definition and it often drives the remaining secondary elements. Every time a change to scope occurs, we are often required to review the Time and Cost baselines to reflect the project definition evolution. Traditionally the final project cost is compared to the initial starting cost without taking into account the evolution of the scope and project definition. This doesn't provide a proper indicator of a project performance. We have seen that several major solutions went over budget and took more time but still were considered a success. If project cost and time baselines were updated based on scope evolution, there wouldn't be such large gaps between the actual cost and budgeted cost at the end of the project.

H2: Project definition and scope are shaped by multiple influences exogenous to the project boundaries as well as by emergent uncertainties endogenous to the project boundaries.

Multiple Influences that are exogenous to the project boundaries and that emanate from different elements have a direct and indirect impact on the project definition and scope of a major innovative solution. These exogenous elements can come about from: External Environment, Internal Environment, Time Constraint, Market and Stakeholders. Each of these elements is detailed and explained below with some examples.

Two types of Emergent Uncertainties coming from the internal boundaries of a project can bring changes to the project definition. These uncertainties can be grouped in technological elements and solution related elements. This will be further described below.

In our research we will test this hypothesis against two medium to low innovative solutions. This will help us understand if the same elements play a role in the case of less innovative and strategic solutions.

H3: High innovative solutions are triggered by both exogenous and endogenous changes while medium and low innovative solutions are mainly triggered by endogenous changes.

Following the second hypothesis, we expect that both high innovative and less innovative solutions are shaped by the same elements identified in the conceptual model. Highly innovative solutions are impacted by both exogenous and endogenous variables. High innovative solutions often involve multiple BUs and are strategic to a Bank. They can be driven by external needs or business needs. System integrators are also more involved in such innovative solutions and they have an important role to play in a co-opetion context. On the other hand less innovative systems are usually less important. They are often a replication of a successful solution and hence are not subject to the same contextual elements. Less innovative solutions tend to be mainly shaped by endogenous elements.

In other words, innovative proprietary solutions are associated with a dynamic project definition and scope evolution which are shaped by Exogenous Multiple Influences and Endogenous Emergent Uncertainties elements. Subsequently, we will present the conceptual model and explain each of the independent and dependent variables.

3.IV. Conceptual Model and Variable Explanations:

Below is a graphical representation of the conceptual model developed in this research. It links the independent variables grouped in two categories: Multiple Logics and Uncertainty to the dependent variables grouped under project redefinition. The unit of analysis which links these two types of variables is the Change Request. Each of the elements represented in the Figure 3.1 will be explained in what follows.

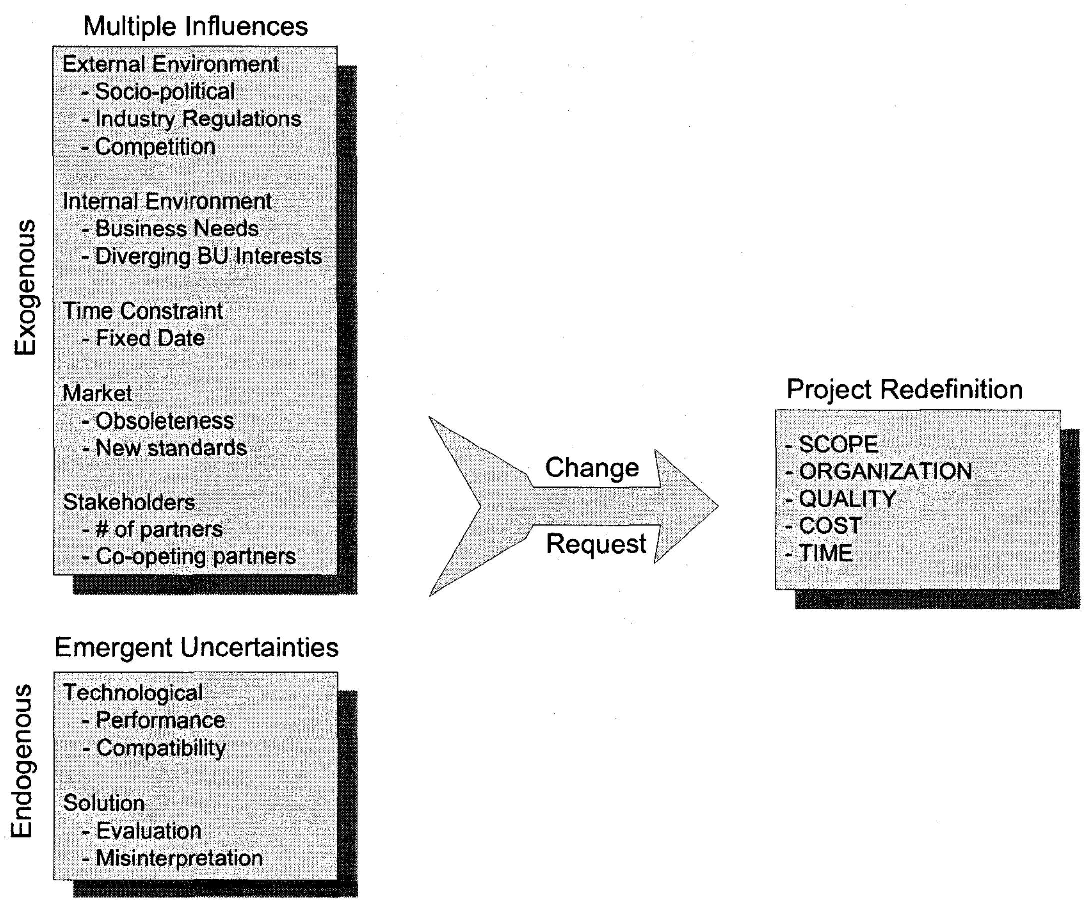

Figure 3.2: Conceptual framework

3.IV.A. Independent variables

After conducting exploratory case studies and studying several projects, two main groups of independent variables were identified. The first group accounts for the exogenous elements composed of multiple influences that can be complementary or contradictory and have an impact on a particular project. These exogenous multiple influences are summarized below:

Exogenous – Multiple influences – External Environment

Socio-political: New socio-political regulations can be enforced during a project lifecycle and impact its scope. For example the recent DST (Daylight Saving Time) amendment that became mandatory to implement at specific time. Some IT projects that were in the implementation phase had to adjust to these changes.

Industry Regulations: New regulations can be amended again and again even after a company has begun the initial implementation of the new regulation. For example the Check Imaging initiated by the Canadian Payment Association was amended and clarified on several occasions even after banks have started on implementing the solution.

Competition: Competition is another external factor that can have an impact on a firm's behaviour and hence it's solution definition. Some Canadian banks are planning to launch the IC Card or Chip Card in mars 2008. The remaining banks should try to meet this launching date or else they might loose some potential clientele. Lately, ING bank introduced a high interest saving's account. This move was followed by several banks that introduced equivalent high interest rate for a given period of time. Furthermore, banks are offering more incentives and gifts for clients to transfer their accounts. This illustrates a high competitive environment. Such initiatives generate changes in a solution's scope to adapt to the external environment and maintain a competitive advantage.

Exogenous – Multiple Influences – Internal Environment

Business needs: Business requirements can evolve during the solutions life cycle. Firms can develop new strategies, new products or bring changes to existing functionality. A client can also change the business requirements because of a better understanding of the target solution. Some clients can decide to cut on some functionality because of new financial constraints that did not exist in the initiation phase.

Diverging BU interests: Large integrated solutions involve several business units and can last for several months or even years. Each business unit has its own projects that might share some common infrastructure with the new solution. This can create conflict as to which project gets the priority. Another example is ins the case of a new infrastructural project, a business unit can be forced to migrate its solution to new software versions. This can lead to some incompatibility and generate new development that the business unit is not ready for.

Exogenous – Multiple Influences – Time Constraint

Time Constraint: the time factor exists in both external and internal logics. Most industry regulations have a target date to be met by financial institutions. Internal and specific Business needs can also be driven by time. This pushes the project into a fast track mode. The design and implementation phases will be in tandem for a certain period.

Exogenous – Multiple Influences – Market

Obsoleteness: software companies are continuously upgrading their products and introducing new versions and new functions. With the introduction of every new version, software companies cease to support an old version. Example a software company supports only the last 5 versions developed and sold. This pushes clients to continuously update the software used in their proprietary system. With every new version come several technological uncertainties such as performance, compatibility and security issues. Software updates can occur during a project lifecycle and as a result cause scope changes.

New Standards: New standards are continuously developed and introduced. This can occur anytime during the lifespan of a project implementation.

Exogenous – Multiple Influences – Stakeholders

Number of Partners which are involved in the development of the proprietary innovative IT solution. Financial institutions hire specialized consultants or consulting firms to assist them in implementing innovative solutions and introduce new technologies.

Co-opeting Partners: These partners are usually competing at the industry level while they have to collaborate together to achieve a common objective on the project level. Therefore multiple logics face each partner. This often requires continuous scope management across the project lifecycle.

Endogenous – Emergent Uncertainties – Technological

Performance: despite pilot projects, we cannot guarantee the performance of a new technology that is implemented in a complex technological structure. Financial institutions have numerous interconnected proprietary systems. Such systems are also composed of commercial specialized modules developed by independent IT firms. We can't accurately guarantee the performance of a new system or solution when hooked to the company's infrastructure. Performance also covers security issues and robustness of a solution.

Compatibility: Newly developed solutions should be compatible with existing systems and modules. Any new system can have an impact on any of the interconnected modules. Scope adjustment is often necessary when the new system is implemented within the firm infrastructure.

Endogenous – Emergent Uncertainties – Solution

Evaluation: Uncertainties in evaluating the effort required to implement an innovative solution are usually higher than in the case of standard or repetitive applications. Resources can hardly and accurately determine the time required to develop a complex innovative solution. Evaluation uncertainties are often associated with an impact on the time and cost factors. It is not strongly correlated with scope changes because it does not question the solution's design.

Misinterpretation: When several partners work on a common solution, misinterpretation can result in the understanding the solution's specifications. This also applies to conflicting roles and responsibilities among different partners with respect to the execution of specific activities. On the other hand, in a traditional cascade model, the design phase is separated from the execution phase. Different teams usually work on these two phases. The design documentation generated by the design team can be misinterpreted by the execution team. This type of misinterpretation also applies from the business need elaboration and the design phase.

3.IV.B. Dependent variables

The dependent variables are detailed in chapter_2_IV. They are grouped under the project redefinition and summarized below.

Project Redefinition:

Project definition is composed of five elements which are the following: Scope, Organization, Quality, Cost and Time. In the context of an innovative complex proprietary IT solution, these five variables evolve along the project's lifecycle. Multiple logics and uncertainty factors generate changes that impact the elements of the project definition. The following summarizes these five elements:

1) Scope: PMBOK defines scope as "the sum of products, services, and results to be provided as a project". It covers work that needs be done to deliver a given solution determined by a specific business or need.

2) Organization: The organization is composed of all the resources that are put together to carry out a given project. Turner specifies that the project organization's objective is "to marshal adequate resources (human, material and financial) of an

appropriate type to undertake the work of the project, so as to deliver its objectives successfully" (Turner, 1993:135)

3) Quality: the PMBOK defines quality as "the degree to which a set of inherent characteristics fulfills requirements". The quality factor also covers the methodologies put in place to achieve a given project.

4) Cost: A Project Cost usually covers labor hours and material cost such as hardware or software. Cost can be direct such as a new server dedicated to the project's solution or indirect such as overhead facilities. Another dimension to cost is variable vs. fixed. The first varies in function of time, effort or work, while the second consists of a predetermined price that is independent of the effort or time required to perform the activity

5) Time: according to Turner (1993:206) time or schedule is "a series of dates against the work elements in the work breakdown structure, which will record our forecast of when the work will occur and when the work actually does occur."

3.IV.C. Unit of analysis

The unit of analysis that will be use in this research is the "change request". A change request is any change to the project definition elements. This could be of several types: 1) scope change related to solution's design, 2) project organizational change which can be related to project structure and contractual agreements 3) quality change which could be a new development process or procedure 4) cost change which is associated with budget and 5) time change such as a new implementation date. A change request can consist of one or several types simultaneously. The PMBOK defines a change request as a "Request to expand or reduce the project scope, modify policies, processes, plans, or procedures, modify costs or budgets, or revise schedules. Requests for a change can be direct or indirect, externally or internally initiated, and legally or contractually mandated or optional. Only formally documented requested changes are processed and only approved change requests are implemented." The Change Request will be further detailed in Chapter_4_I.

Based on the selected projects this research will analyze the multiple change requests that were issued during the solution or project lifecycle. Each change request will be analyzed and mapped to the variables identified in the conceptual model. The input of the change request is mapped to the independent variables and the output is mapped to the dependent variables.

More than 500 change requests were analyzed for this research. The conceptual model evolved along the data collection and analysis process (Glaser and Strauss, 1967). Several iterations were required to stabilize the conceptual model. After each iteration, all previously analyzed CRs had to be reviewed to validate the revised model. CRs had to be remapped to reflect the changes in the variables of the revised model.

Codification of the change requests was tedious because each program has a different classification of change request. In addition while some projects differentiated between a scope change and a cost or time change other based their change requests only on the cost factor. This required that each change request be reviewed in detail in order to understand it and classify it properly. In several cases I had to go back to other documentation such as contracts and architectural documentation to position the change request with regard to the project definition and scope. More than 500 change requests were reviewed and codified in this conceptual model.

Source – Input

The source or reason a project has issued or approved a change request will be mapped to the independent variables. This will help determine the most common *variables* responsible for scope changes. This cannot be generalized to all projects because every project has its own particularities and features. A project issued from a regulatory change will not have the same group of independent variables responsible for most CRs as a project that is purely related to a business need.

Impact – Output

The impact or the output of the change requests will be mapped to the dependent variables. This will determine to which extent a particular change request had an impact on the project definition elements and scope.

The total number of change requests and their impacts on the project will represent the extent to which a project scope and project definition elements have evolved during the solution lifecycle. This will justify the need for scope management in the case of large strategic innovative complex proprietary projects that are subject to the above mentioned independent variables.

It's important to note that this data cannot be used for statistical purposes and hence cannot generate statistical data that can be generalized and expanded to all projects of the same type. Each project is different and can have one or more predominant independent factors that can generate CRs and hence cause changes to the project definition.

3.V. Methodology and Data Collection

3.V.A. Methodology

According to Yin (1994), case studies are the best suited approach in the following three situations which apply to our research:

"How" or "why" question. The main objective of this research is to understand how a project definition evolves through a solution's life-cycle. Furthermore, such questions deal with operations that need to be traced over time. We can't understand this question if time factor is not taken into account.

Researcher has little control over the event. The field of studies is not a research lab where different variables can be controlled and changed as wished. It's an observation of real life events over which we don't have any control. This research analyzes projects that implemented proprietary solutions in large financial institutions.

Main research focus is on real life contemporary set of events. Most of the analyzed projects in this research are not completed yet. The phenomenon observed consists of real projects that have been evolving during the time-span of this research.

3.V.B. Data Collection

Yin (1994) mentions three principles of data collection which are 1) using multiple sources of evidence 2) creating a case study Data Base and 3) Maintaining a chain of evidence.

1) Multiple sources of information and evidence were used across the five phases of this research (Miles et al., 2003, Yin, 1994). These sources are described below:

Direct interviews: More than 70 persons were interviewed during this research. Interviewee belonged to different hierarchical positions within the firms; C-Level, Senior VPs, VPs, Principals, SBU Heads, Program Directors, Project Managers and

Architects. Two types of interviews were used: Open ended interviews and focused interviews. The open ended approach was adopted in the exploratory phases 1 and 2 where we wanted to understand a global phenomenon and didn't have a clear research question. This led us to develop our research question and focus on one type of large innovative proprietary strategic and complex IT projects. The interviews conducted in the remaining phases adopted a focused format. The focal point of phases three and four was to understand the project definition evolution throughout the solution's lifecycle. While the central topic of the fifth phase was the solutions put in place by SCE firms and clients to deal with changing project definition and scope.

Documentation: multiple types of documents were gathered and analyzed for each firm and project studied. These include: brochures, white papers, email exchanges, internal documents such as PowerPoint presentations, Project plans and WBS, Visio diagrams and organizational structures etc that companies accepted to share with us.

Archival records: In the fourth phase we concentrated on the unit of analysis which is the change request. For this we went through archival records of the programs studied. More than five hundred (500) change requests were analyzed and codified. Every change requested consisted of an average of 5 pages. Most CRs generated more documentation such as new contractual agreements or changes in the project plans and organizational structure. The additional documentation had to be covered in order to better understand the nature of the change request and hence associate it with the independent and dependent variables.

Direct Observation: The opportunity presented itself to take part in several management and technical meetings where different issues and problems were addressed.

Participant Observation: In our professional career we took different responsibilities in such projects. In the first case we acted as a PM within an SCE firm while in the second case we played the client's role. Among my responsibilities as the client's project director and coordinator, I was in charge of tracking, validating, measuring the impact and approving the change requests issued for the program.

One or more of the five sources of information mentioned above were used to collect data related to each phase of the research. Data was gathered and stored in a database as explained below.

2) The second principle of data collection is to create a case study database. In the initial phases, tools such as Nvivo and MindJet MindManager were useful to structure the interviews but not for the detailed analysis part. For every case study multiple sources of information were gathered in a separate folder. Most interviews were recorded which helped transcribe them. This was very useful because it helped us stay focused during the interview session without losing any data or information.

In the fourth phase which consist of a detailed analysis of more than five hundred (500) CRs, other tools were required. The most convenient was to build a data base using Excel. A separate workbook was used for each program. The workbook was composed of multiple sheets corresponding to each project within the program. Every change request was codified in one line of the excel sheet. The main elements of a change request listed in Chapter_4_I were used as the headers of the excel sheet. In order to properly codify each change request, a detailed review of the CR in addition to all documentations associated to it was necessary. Moreover, in each excel sheet, columns that reflected the independent and dependent variables of our conceptual framework were added next to the columns summarizing the CR. Every change request was then mapped to the conceptual model and hence linked to the independent and dependent variables described above.

Not to forget that the conceptual framework evolved as the CRs were codified. For this several iterations had to be performed reviewing all change requests to stabilize the framework.

Afterward, summary tables were generated based on each program and a horizontal review across all programs was performed.

3) Maintaining a chain of evidence: All collected data was grouped according to the phases of this research. This helps trace back the evolution of this research from the initial phase to its completion. Furthermore multiple backup copies were saved frequently which can also explain the evolution of the data collection process. Moreover most static documents are dated which help trace the time when a particular document was saved. As for dynamic and evolving documents, they were backed up on a continuous basis.

3.V.C. Projects to be studied and analyzed

The following is a list of five programs/projects that will be part of this study. Different types of programs have been chosen to confirm the results. Two cases are the result of external regulations, two cases deal with a technological migration and one project with a solution or application development.

Each of these programs or portfolios is composed of several concurrent projects that are to be managed under a common structure. Below is brief introduction to each of the five programs/projects. Three main Canadian financial institutions are covered in these projects. For confidentiality reasons, the financial institutions will be referred as A-Bank, B-Bank and C-Bank. No financial data will be presented in this research. A detailed analysis will be performed for each project (Yin 1994).

Internet Infrastructure Revamp

The demand for internet banking is continuously increasing. At the same technology is evolving. Faster and more efficient machines and systems are reaching the market. In a strategic move to position itself for future expansions, A-bank decided to migrate its internet banking infrastructure to a completely new state of the art platform. The latter is a première meaning that the bank and its system integrators cannot capitalize on previous similar infrastructural migrations. Not to forget that the bank's solutions are proprietary and unique. A deadline was imposed by senior managers with high performance standards. To meet the deadline multiple phases had to run in parallel. A large number of CRs requests originating from multiple elements of the conceptual model had an impact on the project definition. This will be explained and detailed in Chapter_4_II.

Check Imaging

The Canadian Payments Association (CPA) in conjunction with Canadian financial institutions have put into force a new check processing system using image technology. This newly implemented initiative allows checks to be cleared electronically and as a result more efficiently.

These new regulations aim to modernize Canada's check clearing system using image technology. Regulations are effective as of June 30, 2007. Financial institutions such as banks are required to modernize and update their check clearing systems by this date.[22] Two financial institutions will be covered for this case study: A-Bank and B-Bank. A brief background of the regulation will be presented. This will be followed by an analysis of all CRs reported in this project and their impact on the project definition. The Check Imaging case is detailed in Chapter_4_III.

Basel II Accord

Following Enron, WorldCom and Xerox scandals, senior financial regulators pushed to rigorously implement risk-based prudential rules. One of the initiatives was the Basel II capital risk rules[23]. This new accord aims to:

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[22] (http://printers.sourcetech.com/micr-toner/micr-toner-canadianFAQ.asp)

[23] http://findarticles.com/p/articles/mi_m2633/is_4_16/ai_92725514 - International Economy, The, Fall, 2002 by von Klaus C. Engelen

- Make sure that the capital allocation of a Bank is correlated and proportionate to its risk factor,
- Take apart operational risk from credit risk,
- Attempt to lower the scope for regulatory arbitrage.

Such a program has an impact on most of a bank's business units. It consists of a global program that brings changes the procedures and the way a bank used to function. Organizational impact is important. Similar to the Check Imaging program a fixed date is imposed by a regulatory body that is part of the bank's external environment.
Two different approaches have been adopted by banks to comply with the Basel Accord. The first is a sophisticated approach to measuring risk and meet the Accord's deadline. The other is basic approach measuring risk which compels the bank to put aside a larger capital reserve[24]. Two banks are covered in this case: A-Bank and C-Bank. The case is detailed in Chapter_4_IV.

Intranet Infrastructure Migration

Following the success of the previously described Internet Infrastructure Revamp, A-bank opted for as similar move for its internal web-based applications. This project is flagged by the A-Bank as medium innovative because the bank has already undergone in other BUs similar migration. This project was chosen to understand the dynamic and evolution of project definition in the case of medium innovative projects. It's a similar project to the previous one and hence the innovation factor is weaker. It is noticed that the evolution of project definition and project scope was less pronounced then in the previous case. This is mainly due to a validation phase where experts of the previous project reviewed the architecture and design of this project and made appropriate changes based on their newly acquired expertise before contracts were signed. Despite the validation phase we also notice that several CRs were reported in such a project and

[24] http://www.canadaone.com/ezine/briefs.html?StoryID=03Jul25_1

had an impact on the project definition. This case will be detailed in Chapter_4_V. The validation phase will be explained and detailed in Chapter_4_VII.

Application Revamp

The last case covers an application revamp. A-Bank had just finished rewriting an old application that was becoming obsolete. After the success of this initiative, the bank decided to undertake the Application Revamp project for two other applications that were lacking performance efficiency and several functionalities. Both applications will be merged into one application that will be developed with a new software language and new system architecture. This will add several functions to both applications and will improve operations. Several manual steps will be automated reducing errors and saving time. The Application Revamp project is detail in Chapter_4_V.

CHAPTER 4: Research results and analysis

4.I. Change Request

The unit of analysis used for this research is the Change Request. A change request is any change to the project definition. These are of several types:

1) scope change such as a change in the solution's architecture,
2) project organization change such as contract types or project roles and responsibilities
3) quality change which can be a new quality or testing process/procedure
4) cost change which usually implies new budget and
5) time change such as a new implementation date. A change request consists of one or several types simultaneously.

According to the PMBOK a change request is a "Request to expand or reduce the project scope, modify policies, processes, plans, or procedures, modify costs or budgets, or revise schedules. Requests for a change can be direct or indirect, externally or internally initiated, and legally or contractually mandated or optional. Only formally documented requested changes are processed and only approved change requests are implemented."

Some firms track any change to the baseline of a project through a Change Request. Others log change requests only for financial variations. The following summarizes the most common elements included in a change request. These elements are grouped into 5 categories:

1) Change Identification,
2) Change Description,
3) Impact,
4) Approval and
5) Appendix.

A template of a Change Request is presented in Figure 4.1.

4.I.A. Change identification:

Within the change identification category, seven elements are considered:

Project Name: This should identify the program and/or project name as well as the project number and also specify the contract number if different. In some cases it also includes a financial or accounting reference.

Change Request Title: A short description of the CR is entered in this field. The file name of the change request should follow a naming convention that helps trace it without having to open the file. This naming convention usually includes the CR number, project number, the partner issuing the change request, the change short name, the issuing date and the version. An example of a change request naming convention is: CR001_12345_ Firm1_FunctionABC_ 071231_v1

Date: This is the date when the CR is issued.

Initiator: the change initiator is the person who reports or files the change request.

Sponsor: The project sponsor is usually a client or manager who has the authority to approve the change request.

Project Integrator: He is the project manager that integrates and coordinates the activities of different partners that usually come from different companies. He normally validates the change request before submitting it to the sponsor.

Classification: A change can be classified as: 1) Critical i.e. its inclusion in the project definition is mandatory in order to meet the project objectives; 2) Major i.e. if not implemented it will have a some negative on the project; or 3) Minor i.e. if not enforced project objectives won't be compromised (usually tagged as a Nice to Have).

4.I.B. Change Description

In the case of the change description category, here 4 elements are considered:

CR Description: This element clarifies and explains the reason why this change request is required. It can refer to any of the factors already identified in this research's model. It can also provide a historical background to a contract or an architectural documentation.

Assumptions: this element lists the assumptions on which the change request is based on. Assumptions could be related to dependencies on other projects or partners i.e. the CR assumes that project A will be completed on time. Assumptions can also clarify expectations or confirm previous contractual agreement.

Inclusion: This part will cover the activities required to complete the CR. It clearly lists all activities, documentation and/or artefacts the project will deliver.

Exclusion: It is important for the party that issues the CR to mention any activity that is not covered. This usually applies to activities that should be performed by other parties or fall in grey areas.

File name: C:\...\CR001_12345_ Firm1_FunctionABC_ 20070101_v1

Change Request Identification		Number	001
Prog. Name	Basel II	Project #	12345
Proj. Name	Risk Module	Fin. Ref.	54321
CR Title	Function ABC truncation	Date	20070101
Sponsor		Integrator	
Category	Critical ☒ Major ☐ Minor ☐	Initiator	

Change Request Description	
Description	
Assumptions	
Inclusions	
Exclusions	

Impact			
Scope	Yes ☒ No ☐	Quality	Yes ☒ No ☐
A short description		A short description	
		Cost	Yes ☒ No ☐
		Days : 123.5 days Dollar : 999.999 dollars	
Organization	Yes ☒ No ☐		
A short description		Time	Yes ☒ No ☐
		Previous Date : YYYY/MM/DD New Date : YYYY/MM/DD	

Status		
Approved ☒	Cancelled ☐	Rejected ☐
Sponsor Name:	Signature:	Date:
Partner Representative:	Signature:	Date:
Other Party:	Signature:	Date:
Appendix		

Figure 4.1: Change Request Template

4.I.C. Impact

The impact category is comprised of the following four elements:

Scope: any changes to the architecture or solution's design are usually reported in the scope change

Organization: Changes the project organization such as shifting roles and responsibilities from a partner to another or adding a new comity to track and manage project scope changes.

Time: the time element is tagged when a CR has an impact on the date of a project outcome. It should specify the new target date with respected to the approved date.

Cost: the cost element reports any changes to the cost baseline of the project. This could be positive/negative if the CR requires additional/less money to complete the project. Furthermore, the source of the money should be specified. This additional cash could be from the contingency which is usually managed by the project integrator or from an additional budget to be allocated for the project by the client.

Quality: This reflects any changes to the performance requirement of the target solution. Examples are higher number of transactions per second or faster system response time.

4.I.D. Status

The status category consists of the following three elements:

Status: the status refers to whether the CR is approved, cancelled or rejected.

Signatures: a CR is considered an amendment to a contract and requires the signatures of the parties bound by the initial contract i.e. the client and partner.

Date of signature: Date the document is signed by the designated person.

4.I.E. Appendix

This last section will include any figure, chart, diagram or any additional supporting documentation that clarify and explain the CR. An example is a change in an architectural diagram. The appendix can also include the change request's cost break down which covers equipment, professional service fees etc. Other information is related to some coding elements or structure.

Change requests templates vary from one organization to another. Some firms limit their templates to a few fields, whereas other companies tend to have very long templates to fill. It is important to properly document a CR in order to avoid any misunderstanding. One must not forget that a change request is an extension of the original contract.

In addition, some firms have different types of change requests. They consider that a change request emanating from a scope change is treated differently from a change request reflecting only a delay (time change) or a cost overrun. In the first case the project manager can review the project baseline and hence the project indicators (SPI and CPI) will not be impacted by this CR. In the second case the project manager cannot re-baseline which means that the project performance indicators (SPI and CPI) will be drifting away below the 1 value.

The following sections present a detailed analysis of the CRs reported for 5 proprietary innovative IT projects.

4.II. Internet Infrastructure Revamp

4.II.A. Introduction

The Internet Infrastructure Revamp (IIR) program consists of the migration of all the internet banking applications of A-Bank to a new state of the art technological infrastructure. This new infrastructure is a premiere which makes the project highly innovative. Project team cannot capitalize on previously similar initiatives. Technological performance and compatibility with the bank's systems cannot be accurately predicted. Additionally, it is a complex program with more than ten business units and partners (internal and external) that must cooperate in order to achieve common objectives. Several stakeholders are in a co-opetition mode where they have to cooperate and compete simultaneously. Finally, it's a strategic program because it has a direct impact on the business performance and the end-user/client. The A-Bank will be well positioned to process a much higher number of transactions and respond more efficiently to market demand.

This program is mainly driven by three main elements which are: 1) Market/Obsoleteness, 2) Technological/Performance and 3) External/Socio-Political. It is also subject to a lesser extent to other elements such as: 4) Time constraint, 5) Stakeholders, 6) Internal Environment and 7) Solution.

The following section will briefly highlight the evolution of personal banking. Then it will position the program and explain each element of the conceptual model in terms of the IIR program. Moreover, the results of a detailed analysis of the project definition evolution across the complete implementation lifecycle will be presented. Each independent variable of the conceptual model will be mapped to the elements of the project definition using the CR as the unit of analysis. A total of one hundred and eighty three (183) Change Requests are analyzed and mapped for this program.

Finally, the approaches and processes the program management and sponsor put in place to deal with project definition and scope evolutions will be highlighted. These approaches will be detailed in Chapter_4_VII.

4.II.B. Background

Personal banking used to be done at one of the bank's branches. Customers had to visit their branches in order to perform their common transactions. Banks had to open multiple branches in different cities in order to serve the largest possible clientele. These branches generate high operational costs. They require maintenance and several permanent and qualified employees to operate them. With the birth of the internet new ways of personal banking were revolutionized. Internet changed the way people perform their personal and commercial banking.

The last decade saw the birth of virtual banks such as ING which offers higher interest rates on savings accounts and lower transaction fees compared to the other standard banks. ING can achieve this because it cut on the overhead cost of operating several branches. All banking operations are done through telephone or internet banking systems. Only few and small branches operate in major cities. In parallel, most banks are also offering incentives for their clientele to do their personal and commercial banking through the internet.

On the other hand clients can save time doing their banking transactions on the internet. They don't have to take time off to go to their respective branch for basic and common banking transactions. Most transactions can be performed through the internet are: bill payments, money transfer, line of credit application, federal and provincial tax payments, Stock/Option transactions etc. Today clients can even have a pre-approve mortgage through the internet. Likewise a client can view account balance and transaction history, mortgage evolution, RSPs etc. This makes internet banking a very important service banks offer to their customers. For this, banks must have the proper infrastructure to support a growing demand for internet banking.

4.II.C. Raison d'être of the IIR program

The IIR program consists of three main projects:

1) The first is driven by software obsoleteness. Some of the internet application's base softwares have to be upgraded because new versions have already been introduced on the market and current versions used by A-Bank will become obsolete. Software providers are continuously upgrading their products. With every new upgrade a software provider seizes the support of an old version. The average lifespan of a software version is around two years. Should a customer require extended support for its older software versions, he will have to pay extra support fees. Figure 4.2 presents the evolution of the support fees of a software version beyond the official expiry date of 2005. (Numbers represent the proportional evolution of one of the software base support fees of the IIR program).

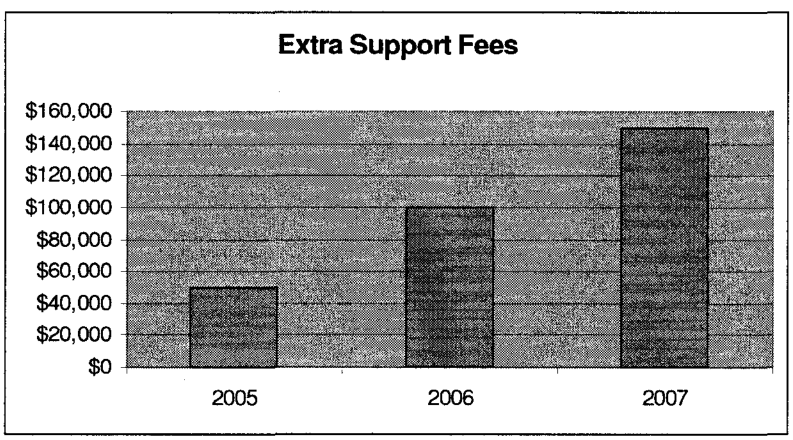

Figure 4.2: Extra support fees of a 2005 expired software version

We can see that the support fees doubled on the first additional year and tripled on the second additional support year that was required by the client.

2) The second main project of the IIR program is driven by technological performance. The current infrastructure is reaching its maximum capacity. A-bank decided to migrate its internet base applications to a new scalable infrastructure that can support the growing number of internet based transactions. This innovative infrastructure utilises a completely new server and system architecture. From this point on, this new scalable and dynamic architecture will reduce operational costs and upgrade costs. When two or more solutions are sharing a common server, changes to one can have a direct impact on the others. Server and infrastructure performance are monitored globally and a problem with one solution can has an impact on all the others. It is important to synchronize the evolution of each solution with respect to all the others. This reduces the windows for upgrades, changes and additions of new functionalities. With this new infrastructure the A-Bank will have more flexibility to evolve and improve these solutions simultaneously. Consequently, it will have the flexibility to allocate the infrastructure resources dynamically based on each solution's needs. It's important to note that this initiative is a premiere and cannot capitalize on previous experience or similar projects.

3) The third project is driven by a socio-political element. In case of a disaster, the bank wants to secure a redundancy site and be capable of maintaining its internet banking services. Following the September 11 attacks, most financial institutions started implementing redundancy systems. Such systems replicate the same operations of the main system and are therefore ready to take over in the case of a disaster. In other words if a disaster or a terrorist attack destroys and shuts down the main building that hosts the bank's servers, all traffic will be redirected to the redundancy site. This site will take over the traffic and secure that customers continue their personal and commercial banking as usual. These new socio-political elements are becoming de facto and as a result all financial institutions should prepare for such circumstances.

Moreover, the program is subject to a lesser degree to other elements which are the following:

4) Senior management imposed a fixed date for the program to be completed. As this project is strategic for the bank, senior managers imposed a deadline date cutting the initial timeline by almost half. This required that multiple project phases run in parallel in order to meet the new targeted date.

5) Another element in this program was the internal environment. As mentioned above multiple business units with different and sometime conflicting needs were involved in this program. Each business unit had its set of evolutionary and major projects that ran in parallel to the IIR program.

6) The complexity of the program resided partly in the number of stakeholders/partners that had to work together under one structure. The stakeholder element of the conceptual model was also a factor that played a role in the evolution of the project definition.

7) The last element was the solution. A highly innovative technological solution makes it hard to evaluate the project efforts and costs and come up with a precise estimate. Because such a project is a premier, solution misinterpretation can result among the client, BUs and multiple stakeholders. In addition, the time constraint forces the project team to start executing the project before the Design phase is completed. The latter is extended and runs in parallel to the Execution phase. Some architectural issues had to be clarified and adjusted along the execution phase.

The following will start by presenting the elements that contributed to issuing change requests. It will analyse the number of change requests related to each element taking into account the nature of the program. It is important to also note that the number of CRs generated by one particular element does not represent the global impact of that factor on the scope evolution. One CR caused by the external environment can have an impact equivalent to more than 10 CRs caused by a solution's misperception.

An explanation of the project definition evolution in terms of the conceptual model will follow. To carry this out, work will be done by subgroups of independent variables and explain how each subgroup impacted the project definition and scope. All elements of the project definition will be analyzed. Particular attention will be drawn to the scope which is the main driver of the remaining elements.

Finally, some of the approaches developed by the project management team and the sponsor to address the above mentioned challenges will be introduced. These will also be discussed in Chapter_4_VII.

4.II.D. Change Requests of the IIR program

The IIR program accounted for one hundred and eighty three change requests (183) which originated from different factors. This is summarized in Table **4.1**. The latter presents the total number of change requests per element and per category of the conceptual model developed in this research.

Table 4.1: IIR – Number of CRs per factor and category

	Category	Factor	# CR / Factor	Classi-fication	# CR / Category	Classi-fication
Exogenous Multiple Influences	External Envi.	Socio-political	5	12	7	7
		Industry Regulation	0	14		
		Competition	4	11		
	Inter. Env.	Business Needs	39	3	53	3
		Diverging BUs Interest	29	6		
	Time	Fixed Date	11	10	11	6
	Market	Obsoleteness	31	5	32	4
		New Standards	1	13		
	Stakeholders	Number of partners	21	8	26	5
		Co-opeting	20	9		
Endogenous Emergent Uncertainties	Technology	Performance	51	2	74	1
		Compatibility	57	1		
	Solution	Evaluation	22	7	59	2
		Scope misperception	37	4		

It is important to note that a change request can originate from more than one factor at the same time. A decision to use Oracle 10 instead of Oracle 8 can be driven by market obsoleteness, technological performance or compatibility and diverging business units needs. Obsoleteness results when the software provider launches new versions and ceases to support an older one. Technological performance is related to enhancement in the new version. In an interconnected system, two business units share and interact with common resources. The other BUs can introduce or develop new strategic modules that require an upgrade of the common database. So totalling the number of change requests in Table **4.1** will result in more than 183 CR.In Table **4.1** we see that the factors that contributed to the highest number of CRs are performance and compatibility. This is

logical and reflects the nature of the project. A highly innovative technological project usually has a high technological uncertainty. The other important category in terms of the number of CR generated is the solution uncertainty. This does not mean that these two groups had the highest impact of the project redefinition as we will see later.
The Internal Business Environment had quite a few CRs. Several BU are impacted by this program. Each BU has its own road map for developing its solutions and systems. Multiple Influences coming from the internal environment led to new change requests. Likewise, the new solution and system architectures are a premier for all parties. This can also be a reason for numerous change requests.

It is important to pay attention to the Time factor. As we see in Table 4.1, Time is classified 10th in the factor ranking and 6th in the category ranking. This classification is misleading because it shows that Time has little impact on the project definition elements and scope evolutions. Having a fixed Time imposed on the project, places the Time factor as a major contributor to the project definition evolution. The time factor is indirectly related to many more CRs. The imposed date became an assumption for the whole program and it was taken for granted by all parties when generating new CRs.

Another thing to take into consideration is that the number of change requests does not represent and is not proportional to the global impact on the project. One CR coming from a particular element has a dollar impact or a time impact equivalent to ten other CRs or more generated by other elements. Some examples are illustrated below.

The next part will study each category and its change requests. It will expand the analysis to the project definition evolution based on these change requests. We will differentiate among all the elements of the project definition namely: Scope, Organization, Quality, Time and Cost. This will help understand and support the first two hypothesis of this research which state that exogenous Multiple Influences and endogenous emergent uncertainties lead to an evolving project scope and changes in the project definition.

Exogenous - Multiple Influences - External Environment

The external environment is composed of three main elements: 1) socio-political, 2) industry regulations and 3) competition. The following will present the change requests that were caused by each of the above three factors and the impact that resulted on each of the five project definition elements. This is summarized in **Table 4.2**.

Table 4.2: IIR – External environment - Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Socio-political	5	3	1	3	2	2
Industry Regulations	0	0	0	0	0	0
Competition	4	1	1	2	2	2
External Environment	7	2	1	4	3	3

Socio-political

The number of change requests coming from socio-political factors was relatively small given that the IIR program is primarily a technological initiative. But the impact generated from these few CRs was enormous. It represents more than 25% of the total budget. This is another reason why we cannot rely only on the number of change requests to determine the global impact of a given factor.

Following the September 11 attacks, most financial institutions launched initiatives to implement redundancy solutions for many internal systems. Banks should develop new

mitigation plans to face a growing risk of potential attacks or disasters that can have a major impact on their operations. Even though internet banking is not the core application of a bank, it is a crucial service that many customers rely on. Internet banking is becoming the main interface between a financial institution and its customers. It can be seen as a virtual branch where customers access and manage their accounts.
After A-Bank started the IIR program to migrate its internet banking to a new state of the art infrastructure, a change request was issued by senior management to implement a redundancy solution. This CR was mainly driven by the socio-political situation where traditional backup solutions are not sufficient to mitigate the new potential risk. The bank needed to have a redundancy solution in a different and distant location in the case of disaster. Such a CR had a direct impact on the main scope of the program. The scope of the program had to be changed and adjusted to include the new redundancy solution. The scope change had a direct impact on the remaining elements. Due to the change in scope, the four other elements namely organization, quality, time and cost were also impacted. A new organizational and program structure had to be developed and a new project created under the IIR program. Quality was also impacted because new procedures and processes were developed for a different type of project. The new redundancy project was more procedural than technological. Finally, more effort and cost were required to achieve this new scope.

Another example of a socio-political driven CR was related to pandemics. In 2003, the city of Toronto saw the spread of SARS which created panic in all surrounding areas. Other examples of possible future pandemics are the Avian Flu or any mutation of a 'super-bug'. A-Bank initiated another project to respond to such a threat. This included providing distant access to bank employees so that they could work from home and not risk being exposed to potential pandemics. Such a project had several dependencies and impacts on the IIR program especially that both projects had partially overlapping lifecycles.

A final example of a socio-political driven change request is the Daylight Savings Time (DST) project. In 2005 the United States Congress passed a new Energy Policy Act[25]. The act was an attempt to address energy problem the USA is facing. Later in the summer of 2006, Canada decided to adopt DST changes. The new rules were to go into effect in March 2007. This triggered a major initiative at IBM to update its base software to reflect this new act. Multiple teams working at the provincial, national and international level were involved to meet the March 2007 date. Such a project had an impact on the IIR program which had to adjust its project plan and resource allocation. Such a CR did not have an impact on scope but on the time factor as several activities and deliverable dates had to be reviewed. This didn't result in more effort or any other impact on the other elements.

Competition

The IIR program is partly driven by competition. The A-Bank should always consider the competition service offerings. This means that the technological solution should at least have similar or even better performance than the competition. This can be translated in the response time, number of transactions processed simultaneously and the percentage up-time.

Several headlines mentioned faults in different bank systems and procedures which can have a negative impact on a bank's image. The solution should be very robust from a technological perspective as well as from a procedural point of view so that the A-Bank won't make bad headlines. This is considered as a competitive advantage with respect to other financial institutions.

In summary, the external environment did not generate a large number of change requests because of the technological nature of the project. Nevertheless the Socio-

[25] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109

Political factor caused a major scope change which had a high impact on all the elements of the project definition. No industry-regulation related CR was reported in this program. The following will detail the elements of the internal environment.

Exogenous - Multiple Influences - Internal Environment

The internal environment is composed of two main elements: 1) Business Needs and 2) Diverging BU Interests. The following will present the change requests that were caused by each of these two elements and the impact that resulted on each of the five project definition elements. Below these relations are covered through a few examples taken from the IIR program. This is summarized in **Table 4.3**.

Table 4.3: IIR – Internal Environment - Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Business Needs	39	30	7	7	23	31
Diverging BU Interests	29	21	1	3	17	22
Internal Environment	53	40	5	8	33	43

Business Needs

In order to survive and succeed in the new economy a firm has to continuously innovate and bring changes to its service offerings, procedures etc. The IIR program involves several Business Units and spans over a relatively long period of time. New business needs can be expressed by any of the BUs impacted by the IIR program. BUs cannot wait until the program is completed before implementing the new requirements. For this they either launch new projects that will run in parallel to the program or integrate the new requirements in the program scope. BUs cannot wait until the program is completed before implementing new Business Needs. The IIR program had to establish a new committee that tracks all changes across all BUs and make sure that there are no conflicts among the different projects that are running in parallel. This required a weekly follow up through a centralized committee in order to avoid conflicting situations. The institution of the new committee illustrates a change in the project Organization and the Quality process of the IIR program. It also required that a separate budget be allocated for these additional efforts.

Whenever new Business Needs were integrated into the program, the scope had to be adjusted consequently. We notice in **Table 4.3** that a larger number of CRs impacted Scope as compared to the other project definition elements. This is because some of the scope changes are absorbed by project Time and Cost estimates. The time a change request is issued with respect to the project lifecycle is a good indicator of the impact. If for example a scope change to a given function is issued before the development of the function starts, the impact on the remaining elements would be much lower than if the change is brought in the final testing phase. For this reason, a project should impose time frames where changes are less welcome because of major impacts.

It was also noticed that one change in business needs can generate multiple CRs from the different parties or partners involved in the program. Hence the number of CRs reported and analyzed does not reflect the number of changes in business needs. But each CR may have its own impact on one or more of the project elements. This could be limited to Cost because of new equipment. It is also related to time when a deliverable's date is postponed or more effort is required.

It's important to note that changes in Business Needs are highly correlated to changes in scope. This is often associated with an impact on Cost and Time. Organization and Quality are less impacted because they tend to be more stable along the project lifecycle.

Div. BU Interests

Business Units are quasi independent entities that have their specific and different strategies in relationship to their products and markets. Each BU can have different specialized solutions and software providers that serve a vertical market. A given BU might need to use a third party provider's solution that best fits its business needs but is in conflict with the standard common shared infrastructure. This leads to diverging BU interests. These Multiple Influences are often resolved by changes to the scope of both projects seeking a fit that best suits both parties.

Another example is when the project office developed new dashboards and project templates where CPI and SPI are reported in order to track global portfolios at the organizational level. The IIR program project management team was not using these indicators to track project progress. The documentation and procedures used in the program couldn't respond to such a requirement. A CR had to be issued to modify the project reporting procedures and processes in order to include these new elements.

Exogenous - Multiple Influences - Time

The Time category is limited to only one factor: Time. As explained earlier a fixed deadline was imposed on the program from senior management. The program parties considered the Fixed Date – Time factor as a de facto and did not report or consider it in their CR evaluations. Table xx represents the number of CRs caused by the Time factor as well as the impact on the five project elements.

Table 4.4: IIR – Time – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Time	11	6	5	3	9	9

The fixed deadline had several impacts on the project definition and scope. The project team had to start several activities in parallel despite the fact that architectural documentation was not completed. The architectural documentation and project design which define the project scope had to evolve during the project implementation lifecycle. To account for this dynamic situation, the program management brought some changes to its organization. A new committee composed of architects coming from the different parties involved in the program was formed. This committee met on a weekly basis to review and clarify the architecture and design as the projects were being executed. In addition the committee group was responsible for determining and evaluating if new scope changes were required. In other words the committee was the watch dog of project scope. This also had an impact on the quality process. The design committee will be addressed in Chapter_4_VII.

The time element led also to a new project organization on the management side. The role of the system integrator was reviewed. A technical 'system integrator' role was differentiated from the management 'system integrator' role. Different persons assumed these roles. Technical system integrator roles were attributed to the partners according to their expertise. Such managers came from the partners and were close to technical people. Management system integrator role was attributed to a program manager that comes from the client's organization. This person was responsible for the interaction among all Bus, client management and all partners and stakeholders.

The Time element of the project definition was also impacted because project planning was reviewed to meet the target deadline. A fast track plan was elaborated which reflected concurrent phases.

Finally contractual arrangements with multiple parties were re-evaluated and the Cost element was adjusted accordingly.

Exogenous – Multiple Influences – Market

The Market Influences come from two main factors: 1) Obsoleteness and 2) New Standards. The following will summarize the number of change requests that were caused by these two elements and the impact that resulted on each of the five project definition elements. The market influences generated a large number of change request. This is also due to the nature of the IIR program. A summary of the total number of CRs generated by the Market Influences category and their impact on the project definition and scope is presented in **Table 4.5**.

Table 4.5: IIR – Market – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Obsoleteness	31	23	0	3	21	26
New Standards	1	1	0	0	1	1
Market	32	24	0	3	22	27

Obsoleteness

Obsoleteness was responsible for thirty one change requests. Twenty three CRs had an impact on the project scope. This was also reflected on the Time and Cost factors.

The IIR program spanned over a period of around two years. We have seen earlier that software providers introduced new releases and new versions on a frequent basis. Several 'base software' saw new releases launched since the initiation of the IIR program and before the Go-Live date. At the same time software companies stopped the support of older software versions. The IIR program had to adapt to this dynamic environment and reflect new versions in its architecture and design.

Additionally, a lack of compatibility between the IIR system that has a new 'base software' version and one of the A-Bank's systems running on a module with old software could be the result of obsoleteness. New standards or obsoleteness could also be the result of other interdependent projects implementing changes.

Exogenous - Multiple Influences - Stakeholders

The Stakeholders' category accounts for two main elements: 1) number of stakeholders and 2) Co-opeting stakeholders.

Several stakeholders were involved in the IIR program. Some stakeholders were system integrators coming from firms that were competing on the industry level but had to collaborate on the program level. Table 4.6 represents the number of CR caused by the Stakeholders category as well as the impact on the five project elements.

Table 4.6: IIR – Stakeholders – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
# of Stakeholders	21	13	5	6	14	18
Co-opeting Stakeholders	20	13	4	6	12	18
Stakeholders	26	16	6	7	16	23

Number of stakeholders

Each stakeholder has an independent contract with the A-Bank. The contract usually covers a particular and well defined scope. When a new business need that has an impact on the program definition emerges, multiple contracts with different partners require changes to adjust their corresponding scope. Consequently, every change to any of the contracts with the different parties leads to project redefinitions.

Coordinating changes across multiple stakeholders becomes a tedious process. Some managers enforce a validation phase where all parties are gathered and new changes to contracts are reviewed to make sure that everybody agrees with them.

This was the case when the IIR program had to include the redundancy project in its scope. The A-Bank asked that all parties involved take part in new contract reviews. This was done by gathering all the parties involved in the ecosystem and have them review all contracts.

Co-opeting Partners

The different partners that are collaborating to achieve a common program objective can be competitors on the industry level. This co-opeting status of these partners can result in multiple Influences whenever a need or change arises and is not in the approved scope. Within the IIR program, the technical team noticed that some external emails needed to be replicated. This need was neither known nor included in the initial scope but was required to achieve a complete solution. Two of the parties working on the program presented two different solutions. Party A proposed to develop a small replication module while party B suggested the A-Bank use a software application for this purpose. The software application was developed by party B. This situation is an example of a co-opetion environment that can exist among multiple parties working on a common program. Both solutions had a similar cost. Scope had to change whether opting for the first or second solution. The A-Bank problem was to determine which solution best fits its needs. The bank could not rely only on the suggestions of each partner. The recommendations of an internal bank expert become very important in such cases.

Moreover, a partner faces the possibility of having its activities transferred to the other competitor during the program lifecycle. A change coming from the corporate head office saw some networking activities outsourced to an external party. The internal networking group that was responsible to execute these activities had to modify its scope to reflect the new decisions. This might not constitute a global scope change in terms of the solution definition. But it has an impact on the contractual scopes of concerned parties. The client usually opts for such a move for different reasons such as the enforcement of new quality standards, cheaper cost, lack of technical expertise etc. This in turn can impact the IIR program definition.

The following section will analyse the change requests resulting from Endogenous Emergent Uncertainty elements. Uncertainty covers two main subgroups: 1) technological and 2) Solution.

Endogenous – Emergent Uncertainties – Technological

The technological uncertainty is constituted of two main elements: 1) Performance and 2) Compatibility. The following will present the change requests that were caused by each of these two elements and the impact that resulted on each of the five project definition elements. We can recall that this category produced the largest number of change requests. This is due to the technological nature of the IIR program. A summary of the total number of CRs generated by the technological uncertainty category and their impact on the project definition and scope is presented in **Table 4.7**.

Table 4.7: IIR – Technological – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Performance	51	40	1	2	32	43
Compatibility	57	47	1	3	37	48
Technological	74	61	1	3	54	65

Performance

Response time and number of transactions per second are two examples of the technical performance. Security issues can also be related to performance. Robustness such as an electrical fault and a failing memory chip are also examples of technological performance.

In the case of innovative projects, the technical performance cannot be guaranteed even if proven on the theoretical level. No one can accurately predict the behaviour of the new system when hooked to a global proprietary infrastructure. Several adjustments and changes to some architectural components are usually required to meet the intended system performance. **Table 4.7** shows that the IIR had a large number of CRs related to performance and that were correlated to changes in scope. Most scope changes had an impact on the Time and Cost elements. These were relatively low. On the one hand, they didn't affect the global delivery timeframe of the program and on the other hand they were absorbed by the cost contingency or budget reserve allocated to the program.

Initial pilot projects helped the project architects determine the total amount of memory that should be allocated for each server and application. After several tests conducted in a quasi live environment the project team noticed that a change in the memory configuration improved considerably the server performance. On the other hand one of the critical servers required the purchase of new memory chips to meet the performance requirements.

Security is also another example of performance standards. Architects noticed in the execution phase that some of the data transferred between two distant servers was not highly encrypted due to an old version of a software application. This required the addition of an encryption module to conform to high security standards.

When new software versions installed by the IIR program exchanged with other applications, some performance issues were noticed. An upgrade of some 'base software' can degrade some applications' performance. This was the case for the IIR program where new code had to be rewritten to resolve such performance problems.

Compatibility

Compatibility is an important source of change requests where a new solution is introduced to a large interconnected system. Each application or system modified, upgraded or migrated by the IIR program should be compatible with all the other modules and solutions of the A-Bank.

Thirty nine CRs reported in the performance category had a simultaneous impact on performance and compatibility. These two factors are very interdependent.

Endogenous – Emergent Uncertainties - Solution

The Solution's emergent uncertainties are constituted of two main elements: 1) Evaluation and 2) Misinterpretation. The following will summarize the number of change requests that were caused by these two elements and the impact that resulted on each of the five project definition elements. This is illustrated in **Table 4.8**:

Table 4.8: IIR – Solution – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Evaluation	22	3	3	1	14	18
Misinterpretation	37	23	1	0	14	35
Solution	59	26	4	1	28	53

Evaluation

After a client determines its Business Needs, partners evaluate the effort required to develop new functionalities and modules. When similar work has been done previously, it becomes easier for the partner to evaluate the effort required for the new solution. Whereas when business needs involve an innovative solution never implemented before such as the IIR program, it becomes more difficult to accurately evaluate the global effort required to achieve the objective. Innovative solutions can require reworks and more testing. CRs can be submitted by partners to reflect the additional effort required to accomplish the targeted objectives. In **Table 4.8** it is noticed that 22 CRs were filed and had 14 and 18 respective impacts on the Time and Cost project elements. Most CRs required more Time and more Cost which explains the additional work needed to achieve the objectives. In some cases it was seen that some CRs resulted in a negative impact on Time and Cost. This is because the partner added some buffer for a highly uncertain functionality or that some planned activities were not required. Another point to consider is that from 22 CRs we counted only 3 changes to the scope element. This is logical because uncertainties in evaluating the effort to build a given module or infrastructure does not change the specifications of the solution. It was noticed that Uncertainty in the Solution Evaluation is the factor that has the least impact on the project scope. Conversely, it has direct impact on the Cost and Time elements of the project definition.

All contracts submitted by a partner to the client include an uncertainty percentage or cost margin of the overall cost of the solution. The percentage tends to decline as we move across the phases of the project lifecycle. The initiation phase can have 50%, architecture phase 40% and the execution phase 15% uncertainty.

Some clients require that a CR be issued for a partner to use the uncertainty. Others give the partner's PM the latitude to manage his contract's uncertainty.

It was observed that there is a considerable number of CRs related to the uncertainty in the evaluation factor. Most of these CRs were issued by one partner. This partner as opposed to the other main partners had a time and material contractual agreement with A-Bank. Other major partners had a fixed price contract. Here they became responsible for changes resulting from effort evaluation.

Misinterpretation

Misinterpretation is usually related to scope misperception. Different partners have different interpretations of the business needs and the solution's design. When several partners are working on one solution, it happens that some activities fall in a grey area. An example is partner 1 develops module A to produce a Data File. Partner 2 develops module B to process the same Data File. And it is not clear which party is responsible to transfer the file from module A to module B. System integration firms tend to detail all assumptions and hypothesis in their contract. It is important to counter validate the different contracts with all business requirements involving all stakeholders.

On the other hand, and because of time constraints, some architectural documents only presented a high level and global picture of the final solution. To meet a target deadline, the implementation phase had to overlap with the design phase. This can lead to different interpretations or assumptions when different parties develop detailed functional specifications.

In summary, scope misperception occurs when there is a gap between the architectural document and the contract or when a point in the architectural document is not clear enough.

The following section will present some of the strategies and approaches the A-Bank and project team used to handle the different challenges addressed by the IIR program.

4.II.E. Approaches

The IIR faced multiple challenges that needed to be properly addressed to achieve success. The main challenges are: 1) high innovative solution 2) fixed delivery date, 3) complexity generated by a large number of stakeholders and multiple BUs. Below are some of the means and processes the program management and sponsor put in place to deal with project definition and scope evolutions.

Risk sharing

In the initial stages of the IIR program, the sponsor and project team had several challenges in order to scope the solution. All contracts were Time and Material and most of the Risk was assumed by the Bank. Senior management of the A-Bank decided to change the contract type to a Fixed Price contract. With a high innovative project comes large uncertainty in the technological solution as well as in the effort evaluation. This type of contract transfers part of the project risk from the client to the partner.

On the other hand, the technical integration role was also transferred to the partners. A-Bank gave more responsibility to the partners who became accountable for the architectural and solution validations. Partners took an active part in determining the global scope of the solution and in validating that all contracts correspond to the established scope. This reduced the misinterpretation and evaluation uncertainty for the A-Bank. Changes to the contract structure where the client transferred part of the risk and some responsibilities to the system integrators increased to overall cost of the program.

Table 4.8 shows a large number of CRs related to evaluation. Most of these CRs were generated by one partner that had a Time and Material contract. This partner had a relatively smaller implication in the program. The partner didn't have any integration role and the contract constituted a low percentage of the global program budget. For this reason A-Bank preferred to use a Time and Material contract with that partner. The global management integration role was assumed by A-Bank. This role had to deal with all BUs and make sure that all internal and external parties were aligned.

Architectural and Design committee

In a traditional cascade project management model, the execution phase starts after the architectural and design phase is completed. To meet a fixed deadline the project needed to have some overlap in these two phases. In addition and due to the degree of innovation and technological uncertainty involved in the IIR, the expertise of senior architects becomes important along all the execution phase. For that reason program management establishes a new committee composed of architects from all partners. The new committee met on a weekly basis to review and adapt the solution's architecture and make technical decisions. The new system's architecture and scope were dynamically evolving along the project lifecycle as new problems were encountered, test results were produced and data was available.

Another role was attributed to this committee regarding the CR management process. As noted previously, two types of change requests were differentiated in this program:

scope and administrative related changes. The scope related changes were initiated by the Architectural Committee while the administrative related changes were handled by the project management team.

Global delivery calendar

The complexity of the IIR resided partly in the high number of BUs that were impacted by the technological solution. As mentioned above multiple business units with different and sometime conflicting needs are involved in this program. Each BU has its set of evolutionary and major internal projects that run in parallel to the IIR program.

The IIR program management developed a Global delivery calendar where all internal and external projects affecting any of the concerned BUs were tracked. A delivery committee was responsible for updating this calendar on a weekly basis and publishing the new versions to all concerned parties. This provided a dashboard that helped different managers working on different projects plan accordingly. All changes to any of the projects had to be reported to the committee who validated and flagged any conflict. An example of such a calendar is presented in Chapter_4_VII.

Dedicated project team

The complexity of the program resided partly in the number of stakeholders/partners that had to work together under one structure. The stakeholder element of the conceptual model was also a factor that played a role in the evolution of the project definition.

Because of the importance of the program, best resources from multiple system integrators were dedicated solely to the program. One global structure and a projectized team exclusive to the program were formed.

4.II.F. Conclusion

This section presented a detailed analysis of the IIR program. We saw that the latter was shaped by 183 change requests that originated from exogenous and endogenous elements of our conceptual model. These changes had an impact on all elements of the project definition. This supports our second hypothesis where it is stated that project definition and scope are shaped by exogenous and endogenous elements. In addition, this case supports part of the third hypothesis where it is seen that high innovative project are shaped by both exogenous and endogenous elements as opposed to a medium innovative projects that are mainly shaped by endogenous elements.

In addition some approaches used by the project management team to deal with and manage these CRs as well as a dynamic project definition are presented. Four approaches were mentioned which are: 1) risk sharing with different contractual relationships, 2) design committee to manage the CRs logged by different partners, 3) a global calendar to manage multiple projects and initiative of interdependent BUs and finally 4) a projectized structure where all resources are dedicated to the program. These approaches will be further explored in Chapter_4_VII. The following section studies the case of the Check Imaging program.

4.III. Check imaging

4.III.A. Introduction

This section presents the Check Imaging (CI) program undertaken by two Canadian Banks: A-Bank and C-Bank. This program is the result of an industry-wide initiative to modernize the check clearing system.

The Check Imaging program is mainly driven by an Industry Regulation or the External Environment. It can also be related to the Internal Environment where a bank seeks to optimize and improve its check clearing system. Such a program is subject to the remaining multiple Influences and emergent uncertainties mentioned in the conceptual model. A Deadline is set for Canadian Banks to meet the regulation's requirements. Multiple partners composed of external and internal stakeholders have to cooperate to reach the program's objectives. In addition, technological and market uncertainties accompany such a program because of its innovative nature. Finally, emergent uncertainties related to the solution to be implemented are to be considered especially when the solution's specifications evolve throughout the program lifecycle.

Below, a brief background of the Canadian check clearing system is presented. This will be followed by a description of the new regulation as well as its evolution. The main advantages and disadvantages of this program are also highlighted. Then, all change requests issued for this program will be mapped to the conceptual model. This will explain how exogenous multiple influences and endogenous emergent uncertainties affect the project definition throughout the solution's lifecycle. A detailed analysis of one hundred and seventy three 173 CRs is summarized below. Each change request is mapped to the independent variables of the conceptual model namely multiple Influences and emergent uncertainties. The change request impacts are mapped to the dependent variables namely the five elements of the project definition. In addition we will present the approaches used by the project team to manage project definition and scope evolution.

4.III.B. <u>Background</u>

The Canadian Payments Association (CPA) launched an industry-wide initiative to modernize Canada's cheque clearing system by introducing imaging technology. This initiative developed new specifications so that high-quality cheque images are captured and used by financial institutions and their customers in order to make cheque processing more efficient (CPA, Updated 2007).

There are around four to six million cheques that are exchanged on a daily basis among Canadian financial institutions. All cheques must be physically transmitted from the location where they were deposited (an ATM or a Bank) to a centralised processing location. The customer issuing the cheque also drops the cheque at the processing center. The customer's bank clears the cheque through the regional clearing system to the payer's bank. The latter decides to 1) accept the cheque and pay it or 2) return it to the customer bank. Cheques can be returned for three main reasons: 1) dishonoured, in the case where there is no sufficient funds or 2) fraudulent operation or 3) stop payment that the customer has instructed. The process of inter-bank settlement of most of the cheques is done within a business day. But the process of handling exceptions such as no funds or fraudulent cheques, can last for up to three or more days.

In order to better understand the new CPA initiative which is also known as the Truncation and Electronic Cheque Presentment (TECP), this research will trace a brief overview of cheque processing (Watman and Balardo, 2007).

In the 1970's three main processing systems were offered by IBM, Unisys, and BancTec. IBM's 3890 had the best performance and dominated the others with over 90% market share. The processing machine scans the Magnetic Ink Characters

Recognition (MICR) or the Optical Character Recognition (OCR) which are encoded on each cheque. The scanning process helps sort the cheques into pockets. An application running on a mainframe receives and stores the data scanned which covers: bank number, branch number, account number etc.

Some bank branches joined forces and consolidated all cheque processing administrative activities into regional data centers. The processing window was extended because items remain in the processing building and don't need to be sorted to meet courier schedule. Further workflow improvements, report consolidations and automations led to a more cost effective usage of the regional data centers.

In the 90s, the cheque processing of major Canadian financial institutions was outsourced to two system integration firms: Intria and Symcor. These two companies provided the main encoding and capture processes to the six largest Canadian banks.

Today, Canadian Banks are still split into two groups that operate on two independent systems. These systems are developed, maintained and operated by two different system integrators as illustrated in Figure 4.3. Every bank has its own software providers, hardware providers and partners such as system integrators that handle the banks proprietary systems. This is illustrated below in Figure 4.3.

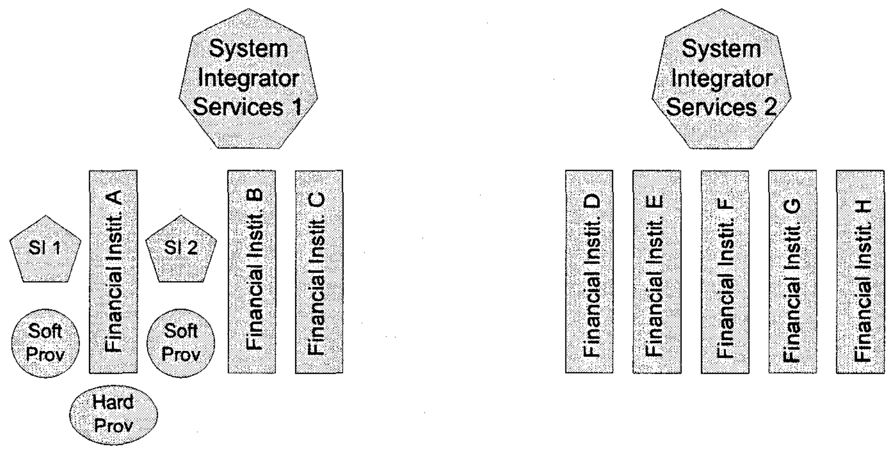

Figure 4.3: System Integrators for the Check Imaging program.

Later the CPA introduced the TECP to modernize Canada's cheque clearing system. All financial institutions must implement this new regulation by mid 2009. In the new system, paper cheques will not be exchanged anymore. Instead, an electronic image of the cheque will be captured and will be used for clearing purposes. This electronic image will be taken at the branch that received the customer's cheque. The separation between the paper cheque and the electronic image is known as 'truncation'. In addition to the cheque image, the MICR data line, which encodes the bank name, account number etc., will be transmitted electronically to the clearing system and ultimately to the bank that issued the cheque. This process is known as the 'electronic cheque presentment'. The physical cheques will be destroyed after a predetermined retention period (approximately two weeks).A summary of the process involving a bank, a system integrator and the CPA systems is presented in Figure 4.4 (Watman and Balardo, 2007).

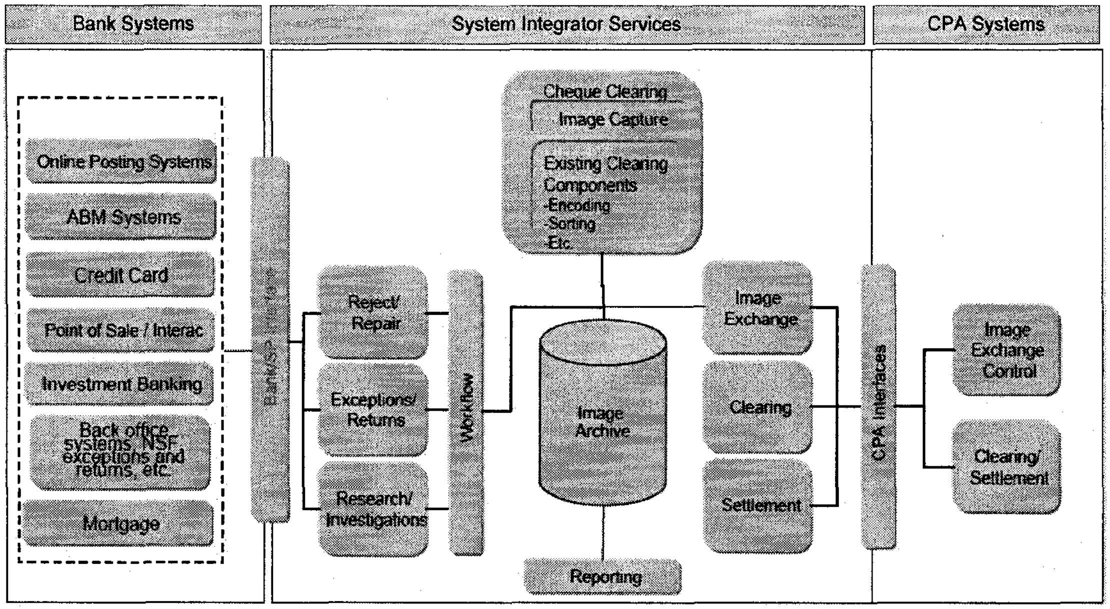

Figure 4.4: TECP process

4.III.C. Raison d'être

This program is divided into multiple projects that a bank has to synchronize with other financial institutions and system integrators. Multiple banks share a common system. Each bank has its own system integrators, software and hardware providers. This creates a complex ecosystem where multiple stakeholders have to coordinate all their activities.

The main advantages of the check imaging initiative can be summarized in the following:

- To increase the efficiency of the settlement and acceptance processes,
- To improve service offerings of financial institutions competitive advantage.

With a common clearing system, Banks need to differentiate themselves with other service offerings. A bank's added value has to be reached beyond the clearing system. The main challenges that banks have to face in order to implement such regulations are summarized below:

- Banks are dependent 1) on each other, 2) on external System Integrators and 3) on changes to the regulations.
- Each Bank has to go through a change management process that covers its front end and the back end office simultaneously.
- New processes should be developed in conjunction with other financial institutions to interact with other banks and financial institutions
- Another challenge related to the solution itself was treating the exceptions. The latter consists of checks with no funds or that require special treatments.

4.III.D. Regulation Evolution

The following will trace the evolution of the regulation. The latter evolved and was clarified even after banks had already started working on migrating to the new system. In February 1992, CPA developed the standard 006 which consisted of the "specifications for MICR-Encoded payment items" (CPA, 2006a, CPA, 2006b). This standard was divided in December 2004 into two parts: A and B.

Many amendments and clarifications were brought to the standard. Thirty five amendments/clarifications were announced pre-November 2003 to the standard. The following is a list of the dates where these amendments were announced (CPA, 2006a, CPA, 2006b):

(1) November 18, 1992, (2) April 28, 1993, (3) October 15, 1993, (4) February 3, 1994, (5) March 31, 1994, (6) June 1994, (7) March 23, 1995, (8) November 27, 1995, (9) March 25, 1996, (10) May 23, 1996, (11) August 23, 1996, (12) September 18, 1996, (13) November 25, 1996, (14) January 27, 1997, (15) October 9, 1997, (16) May 19, 1998, (17) December 3, 1998, (18) December 7, 1998, (19) July 6, 1999, (20) October 7, 1999, (21) March 8, 2000, (22) May 7, 2000, (23) July 24, 2000, (24) October 5, 2000, (25) May 28, 2001, (26) June 28, 2001, (27) July 26, 2001, (28) November 29, 2001, (29) April 15, 2002, (30) July 15, 2002, (31) November 28, 2002, (32) February 20, 2003, (33) March 31, 2003, (34) June 1, 2003, and (35) January 27, 2004.

Furthermore, the following table summarizes ten amendments that were issued post November 2003 (CPA, 2006a, CPA, 2006b).

Table 4.9: Summary of amendments to Standard 006 Post Nov. 2003

No	Approved by board	Effective On	Type of amendment
1	27-Nov-03	27-Jan-04	2.1.3 and 2.7
. 2	01-Dec-04	06-Jan-05	Stand 006 divided into part A (cheques) and Part B (Other doc) The deadline for cheques to comply with the new specifications as outlined in Standard 006, Part A, is December 31, 2006. (NOTE: In May 2006, the deadline for cheques was extended to June 30, 2007)
3	24-Feb-05	25-Apr-05	6.18.3 – reserve paper transaction code 05 for future use
4	2005	2005	ISO format added as a third option for the date field, with bilingual date field indicators allowed in the ISO format
5	15-Jun-05	15-Aug-05	Part A Sec 4.13.2.1 and Part B section 6.18.3 to add a new paper transaction code for US Dollar Items
6		01-Dec-05	Amendment to Appendix IV made under the authority of the CPA General Manager
7	01-Dec-06	12-Jan-06	Clarification standard 006 see below Sec. 5.4.1(6), 6.4.1(8), 5.4.1(9), 5.4.1(11), 5.4.1(12), 5.4.2, 5.4.3 5.4.5(1), and 5.4.5(2)
8		23-Feb-06	Amendments to Appendix IV made under the authority of the CPA General Manager
9		31-Dec-07	Specification for imageabl Bank Drafts, Money orders, inter-member debits, settlement vouchers, point of sale contingency vouchers, canada savings bonds, provincial savings bongs, and canada post money orders added to part A
10	30-Mar-06	28-Jun-06	Clarification part A sec. 1.0, 2.2, 2.14, 3.5, 5.2, 5.3, 5.4.1, and 5.4.5. Formatting and editorial changes made throughout.

Below will be presented an example of two amendments/clarifications in order to understand how this can affect the solution. Items 7 and 10 were chosen from the table above. The following outlines the sections that were clarified and hence potentially caused changes to the solution to be implemented.

Table 4.10: Clarifications to standard 006 Part A, Jan 2006

Clarifications to standard 006, Part A (January 12, 2006)	
Front of cheque	Date field (Section 5.4.1 (6) Amount in figures (Section 5.4.1 (8) Amount in Words (Section 5.4.1 (9) Currency Identifiers (Section 5.4.1 (11)) Informational Printing (Section 5.4.1 (12) Dollar Sign (Section 5.4.2 & 5.4.3)
Back of Cheque	Teller stamp box & phrase (Section 5.4.5 (1)) Endorsement Line & phrase (section 5.4.5 (2) Informational printing (section 5.4.5)

Table 4.11: Clarifications to standard 006 Part A, June 2006

Clarifications to standard 006, Part A (June 2006)	
General	Areas of Interest (Section 2.2) Security (Section 5.2) Payor-filled fields (section 5.3)
Front of Cheque	CPA member financial institution name and address (section 5.4.1 (1) & (2) Cheque Number (section 5.3.1 (4) Date Field (Section 5.4.1 (6)) Amount in words field (section 5.4.1 (9) Currency Identifiers (section 5.4.1 (11) Payable-through U.S. Dollar Items (Section 5.4.1 (11) Payor Name and address (section 5.4.1 (12)
Back of Cheque	Verification phrase (Section 5.4.5 (3))
Teller Stamp Box	Section 5.4.5(1)

The above two tables present two examples of the clarifications/amendments that were introduced in parallel to the project execution. This had the potential to generate change requests depending if the programming of such fields was already completed or not. In the case where such clarifications were introduced at the proper time, system integrators and banks could incorporate them into their solutions with no major impact.

4.III.E. Change Requests Analysis

This program adopted three types of change requests depending on the source. The first type is related to factors from the external environment. This can be in the form of changes to regulations or other external factors.

The second consists of changes that are issued from the client (bank) or the internal environment. These changes emanate from an area of the bank business that is outside the scope of the current project. This can be related to some new business needs, internal project alignment, organizational fit etc.

The last type of change requests originates from one of the system integrators. Two different types of system integrators can be differentiated: 1) the main system integrator responsible for the development of the clearing solution and 2) the remaining partners that support the proprietary systems of the financial institution.

One hundred and seventy three (173) change requests were analyzed for this project. As this research is written, other changes are logged and reported. The following table summarizes all changes logged per category and element. The categories and elements are also classified according to the number of change requests generated by each of them. This classification does not represent or show the importance of one element with respect to the other. One change request coming from one element can have a major impact on the project redefinition equivalent to more than twenty other change requests emanating from multiple elements.

Table 4.12: CI – Number of CRs per factor and category

	Category	Factor	# CR / Factor	Classi-fication	# CR / Category	Classi-fication
Exogenous Multiple Influences	External Envi.	Socio-political	0	12	35	4
		Industry Regulation	25	5		
		Competition	10	9		
	Inter. Env.	Business Needs	44	4	58	3
		Diverging BU Interest	16	7		
	Time	Fixed Date	2	10	2	7
	Market	Obsoleteness	0	12	24	5
		New Standards	24	6		
	Stakeholders	Number of partners	12	8	13	6
		Co-opeting	1	11		
Endogenous Emergent Uncertainties	Technology	Performance	47	3	82	2
		Compatibility	52	2		
	Solution	Evaluation	0	12	124	1
		Scope Misperception	124	1		

The next part will present each category and its corresponding change requests. It will expand the analysis to the project redefinition evolution based on these change requests. The latter will be classified based on the elements of the project definition namely: Scope, Organization, Quality, Time and Cost. This will help understand and support the two main hypothesis of this research which state that exogenous multiple influences and endogenous emergent uncertainties lead to an evolving project scope and project redefinition.

An important element to consider for this program is the difference between a change request that was issued for the whole program and a change request that was related to one or more projects within the program. As mentioned previously, the program is composed of several projects which are usually interdependent. Each project delivers part of the global solution to be implemented. Changes to a project's scope occur without being related to program scope changes. Management can reduce the scope of project A and increase accordingly the scope of project C by transferring activities and work from A to C. An example is when project A depends on some information from a BU, such as a procedure or a functional documentation, to complete a specific function of module Y. The management team can decide to transfer the completion of that particular function from project A to project C which is executed later in order not to hinder the execution of project A. Such transfer of activities result from other factors such as technical issues, conflicting stakeholders etc. They are not related to the program scope as the global work to be performed is still the same.

Therefore, the following will differentiate among program scope changes and project scope changes. One column (PScope – program scope) will be added to the tables that correlate the independent and dependent variables.

Exogenous – Multiple Influences – External Environment

The external environment is composed of three main elements: 1) socio-political, 2) industry regulations and 3) competition. The following will present the change requests that were caused by each of the above three elements and the impact that resulted on each of the five project definition elements. This is summarized in **Table 4.13**.

Table 4.13: CI – External environment - Number of CRs per project definition elements

Multiple Influences	Num	PScope	Scope	Organ.	Quality	Time	Cost
Socio-political	0	0	0	0	0	0	0
Industry Regulations	25	20	14	1	2	22	3
Competition	10	5	10	0	0	9	1
External Environment	35	25	24	1	2	31	4

No Socio-Political changes were reported for this program. On the other hand, industry regulations were clarified even after the program entered the implementation phase as mentioned above. This generated several change requests that had an impact on all elements of the project definition. We can see in **Table 4.13** such changes had an impact on the program level as well as on individual project levels.

Even though several banks joint forces to work and develop two systems, we notice that the competition element between these two groups played a role in the project redefinition. There are two level of competition one that is on the system level where each system is shared by several banks. And the other is at the bank level where each institution has to come with new ways to differentiate its services from the bank it shares the same clearing system with.

Exogenous – Multiple Influences – Internal Environment

The internal environment is composed of two main factors: 1) Business Needs and 2) Diverging BU Interests. The following will present the change requests that were caused by each of these two factors and the impact that resulted on each of the five project definition elements. This is summarized in table XX

Table 4.14: CI – Internal environment – Number of CRs per project definition element

Multiple Influences	Num	PScope	Scope	Organ.	Quality	Time	Cost
BUs Needs	44	13	28	2	2	35	3
Div BU Needs	16	5	10	0	1	10	2
Internal Environment	58	18	37	2	3	45	5

We can notice that a large number of the change requests caused by the internal environment have a scope impact on the project level and few result with changes at the program level. This is mainly the case because projects are interdependent among each other and are related to business units. Changes to evolutionary projects undertaken by different BU have some impact on the scope of one or more projects. This does not change the overall scope of the program.

Exogenous – Multiple Influences – Time

The Time category is limited to only one factor: Time. Because this program is driven by a national regulation, it has to abide with the time regulation time frame. Table 4.15 represents the number of CR caused by the Time factor as well as the impact on the five project elements.

Table 4.15: CI – Time – Number of CRs per project definition element

Multiple Influences	Num	PScope	Scope	Organ.	Quality	Time	Cost
Time	2	1	1	1	0	2	1

As was the case with IIR program the Check imaging program parties considered the Fixed Date – Time factor as a de facto and did not report or consider it in their CR evaluations. For this reason we don't see many CRs emanating from the Time element.

Exogenous – Multiple Influences – Market

The Market uncertainty is constituted of two main factors: 1) Obsoleteness and 2) New Standards. The following will summarize the number change requests that were caused by these two factors and the impact that resulted on each of the five project definition elements. A summary of the total number of CRs generated by the Market element category and their impact on the project definition elements and scope is presented in Table 4.16.

Table 4.16: CI – Market – Number of CRs per project definition element

Multiple Influences	Num	PScope	Scope	Organ.	Quality	Time	Cost
Obsoleteness	0	0	0	0	0	0	0
New Standards	24	18	12	1	2	22	5
Market	24	18	12	1	2	22	5

The program is mainly driven by external regulation. The latter evolved and was clarified after the implementation phase was initiated. The new standards were clarified in parallel to the project execution. This generated numerous change requests. A large number of these change requests were also driven by the external environment element mentioned above.

Exogenous – Multiple Influences – Stakeholders

The Stakeholder category accounts for two main elements: 1) number of stakeholders and 2) Co-opeting stakeholders. Table 4.17 represents the number of CR caused by the Stakeholders category as well as the impact on the five project elements.

Table 4.17: CI – Stakeholders – Number of CRs per project definition element

Multiple Influences	Num	PScope	Scope	Organ.	Quality	Time	Cost
# of Stakeholders	12	4	8	2	1	10	3
Co-op Stakeholders	1	0	0	0	1	0	0
Stakeholders	13	4	8	2	2	10	3

As illustrated in Figure 4.3: System Integrators for the Check Imaging program. above, many stakeholders were involved in such a program. This includes software and hardware providers as well as multiple system integrators. All CR related to the Stakeholders category were also correlated to a different category such as internal or external environments. Some of the new business needs and/or clarifications to industry regulations had to be allocated and shared among multiple stakeholders.

As opposed to the IIR program, most partners were not in a co-opetition model. Each partner was contracted for a specific and clear task. There were no fuzzy activities that could be covered by different partners. This avoided a co-opeting environment where partners had to compete and cooperate at the same time. Only one CR originated from a co-opetition environment.

Endogenous – Emergent Uncertainties - Technology

The technological uncertainty is constituted of two main elements: 1) Performance and 2) Compatibility. The following will present the change requests that were caused by each of these two elements and the impact that resulted on each of the five project definition elements. We can recall that this category produced the largest number of change requests. This is due to the technological nature of the program. A summary of the total number of CR generated by the technological uncertainty category and their impact on the project definition and scope is presented in Table 4.18.

Table 4.18: CI – Technological – Number of CRs per project definition element

Emergent Uncertainties	Num	PScope	Scope	Organ.	Quality	Time	Cost
Performance	47	11	29	2	3	35	4
Compatibility	52	11	28	1	3	32	3
Technological	82	18	47	2	5	56	6

Performance compatibility issues came out throughout the implementation lifecycle of the Check Imaging Program. This is common to innovative solutions where new systems are developed and tested for the first. Such systems have to be hooked and connected to a global proprietary infrastructure. In this case the new system has to interact with several proprietary infrastructures and systems that belong to independent banks. These systems are maintained by different internal BUs or external system integrators and partners.

Endogenous – Emergent Uncertainties – Solution

The last category consists of the Solution uncertainties which composed of evaluation and misunderstanding elements. **Table** 4.19 summarizes the change requests issued for these two elements and their corresponding impact on the project redefinition.

Table 4.19: CI – Internal environment – Number of CRs per project definition element

Emergent Uncertainties	Num	PScope	Scope	Organ.	Quality	Time	Cost
Evaluation	0	0	0	0	0	0	0
Misunderstanding	124	0	13	0	2	5	1
Solution	124	0	13	0	2	5	1

We notice that Evaluation accounts for no change requests. The project team did not track the evaluation elements in the change request. We could not account for precise time and cost evaluations for this program. The program was considered a must and was not justified by a business model specific to each bank. Each bank was trying to reduce the overall cost without tracking the global budget with respect to cost baseline.

On the other hand the misunderstanding element generated a very large number of CRs. We can notice that despite a high number of CRs generated, the impact on the project scope and project definition was relatively low. Most of these changes were absorbed by projects' contingencies.

4.III.F. Approaches used to deal with a dynamic project definition

Two main approaches were used by top management to handle a dynamic project redefinition and scope evolution. These approaches are: Change Management Committee and Projectized Structure (or dedicated team).

Change Management Committee

The main approach developed by the program management to deal with a dynamic project definition was the establishment of a Change Management committee. Before such a committee was put in place there was no way to track and deal with changes to the project redefinition. A large number of changes were reported on a continuous base and no one was responsible for analysing, evaluating, validating and accepting the changes. Situation was chaotic and management couldn't keep track of the project continuous redefinition.

Senior managers decided to put in place a change management committee. A Change management process was drafted and validated and distributed to all stakeholders. This was supported by a documentation that defined the different types of changes and the procedure that should be followed to report and approve a new change request.
Since the change management committee was established, the project definition became more stable and more manageable. Every change was reported and summarized in a global dashboard. This helped management track the evolution of the project definition based on the program objectives.

Dedicated project team

Check imaging is a large initiative which cannot be confined to only one project. Several projects were created under a program structure that governs all parties and stakeholders. Such a program spans over a long period of time. Senior managers assigned and dedicated full time resources to the program. This is beneficial for several reasons:

Resources can concentrate on one project and stay focused.

Technical resources working on multiple independent projects can have different conflicting priorities. When the resource is dedicated to the program, all priorities can be managed internally within the program boundaries.

Accumulated business and technical expertise improve the performance and efficiency of all resources.

Resources coming from different parties evolve for some time in a common environment. This improves the communication and interpersonal interactions.

It is easier to motivate the resources toward a common objective.

4.III.G. Conclusion

This section presented a detailed analysis of the Check Imaging program. We saw that the latter, at the time of writing this research, was shaped by 173 change requests that originated from exogenous and endogenous elements listed in the conceptual model. These changes had an impact on all elements of the project definition. This supports our second hypothesis where we state that project definition and scope are shaped by exogenous and endogenous elements. In addition, this case supports part of the third hypothesis where we see that a highly innovative project is shaped by both exogenous and endogenous elements as opposed to a medium innovative project that is mainly shaped by endogenous elements.

Finally we explained some approaches used by the project management team to deal with and manage CRs and a dynamic project definition. Two approaches were mentioned which are: 1) the change management committee which similar to the Design committee in the previous case and 2) the dedicated project team where all resources work only for that particular project. These approaches will be further explored in Chapter_4_VII. The following section presents the case of the Basel II Accord.

4.IV. Basel II Accord

4.IV.A. Introduction

This section describes the Basel II Accord (BIIA) program undertaken by two major Canadian Banks designated as: A-Bank and B-Bank. This program is the result of an international accord by which major banks have to abide in order to be well quoted on the international market.

The Basel II Accord is primarily driven by the external environment. It is also subject to the Internal Environment because it involves most BUs of the Banks. Multiple BUs have to engage some efforts in order to achieve and meet the regulation requirements and objectives.

This section will briefly introduce the BIIA and describe its main aspects. Then all CRs issued within this program are summarized and grouped by categories of the conceptual model. The particularities of each group are also highlighted.

4.IV.B. History and Background

The Basel Accord consists of recommendations on banking regulations and laws, issued by the Basel Committee on Banking Supervision (BCBS)[26]. The accord carries its name from Basel city in Switzerland where the BCBS established its secretariat. Two accords were issued up to date:

1) Basel I was drafted in 1988 and enforced by law in 1992 in the G-10 countries which include: Belgium, Netherlands, Canada, Sweden, France, Switzerland, Germany, United Kingdom, Italy, United States, Japan. Most other countries have adopted the principles

[26] http://www.bis.org/bcbs/

of Basel I. The accord accounted for a set of minimal capital requirements that a bank should have. It primarily classified the bank assets in five categories according to credit risk.

2) Basel II recommendations are three fold:

1) To ensure that capital allocation is more risk sensitive;
2) To isolate operational risk from credit risk, and quantify both;
3) Seek to align economic and regulatory capital in order to reduce regulatory arbitrage.

"The fundamental objective of the Committee's work to revise the 1988 Accord has been to develop a framework that would further strengthen the soundness and stability of the international banking system while maintaining sufficient consistency that capital adequacy regulation will not be a significant source of competitive inequality among internationally active banks." (BCBS, 2006:16)

Basel II adopts a 'three pillars' concept:

1) Minimum capital requirements;
2) Supervisory review process and
3) Market discipline. In other words BCBS has "expressed support for improving capital regulation to take into account changes in banking and risk management practices while at the same time preserving the benefits of a framework that can be applied as uniformly as possible at the national level." (BCBS, 2006:16)

The first pillar is concerned with the maintenance of regulatory capital that is calculated based on three major risk components a bank faces: Credit Risk, Operational Risk and Market Risk.

The second pillar provides a regulatory response to the first one. It equips regulators with much better 'tools' than those available under Basel I. In addition it gives a framework for handling all risks a bank may face. These are System Risk, Strategic

Risk, Reputation Risk, Liquidity Risk and Legal Risk. The risks are grouped under the heading of residual risk.

The third pillar fundamentally increases the disclosures that the bank is obliged to make. This will allow the market to have a better overview of the global risk position of the bank. This will also permit the counterparties of the bank to properly price and deal.

4.IV.C. Evolution of the Accord

The following will trace the changes in the external environmental variable which can have impact on the program/projects definition.

As was mentioned by several interviewed managers, Basel II has not evolved much since its official publication. This was confirmed by a documentation review of the Accord. The following summarizes the updates brought to the Basel II accord since it was published.

June 2004 (BCBS, 2004): In June 2004, the BCBS published a revised standard about governing the capital adequacy for international banks. The new framework "seeks to improve on the existing rules by aligning regulatory capital requirements more closely to the underlying risks that banks face."[27]

November 2005 update (BCBS, 2005): on November 15, 2005, the BCBS committee published a new version of the Accord. This new release brought changes to the calculation of the market risk and the handling of double default effects (wikipedia). The changes were introduced in a previous paper in July 2005.

July 2006 update (BCBS, 2006): on July 4, 2006, BCBS published a comprehensive version of Basel II. The comprehensive framework is a compilation of the following: (1) the elements of the Basel I Accord which were not revised for Basel II (2) 1996 amendment to the Capital Accord to include Market Risks, (3) June 2004 Basel II

[27] http://www.bis.org/publ/bcbsca.htm

Framework and (4) November 2005 article on the Application of Basel II to Trading Activities and the Treatment of Double Default Effects. This new compilation didn't bring any changes to the Basel II Accord.

Program scope vs budget :

The following Figure traces the budgeted vs real cost of the Accord at the B-Bank over a period of four years. The dollar amounts have been modified and hence don't represent the actual program data. The percentages reflect the actual real data. The years were not specified for confidentiality reasons.

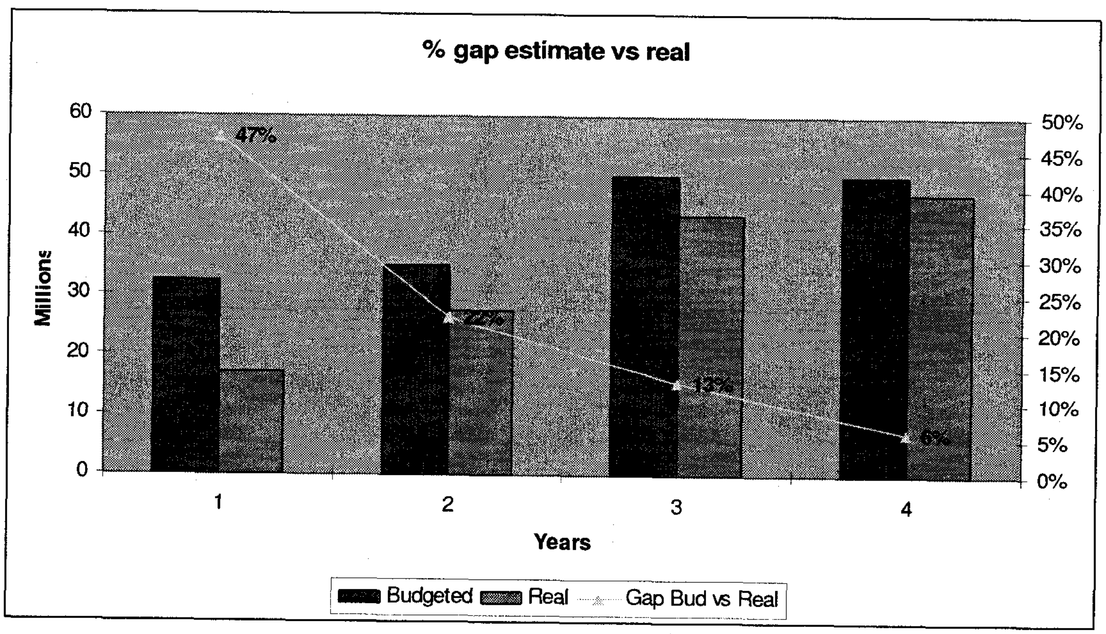

Figure 4.5: Budgeted vs Real Cost of BIIA.

We can see in the above figure that the first year represented a 47% gap between the budgeted and real cost. This gap was reduced to 6% by the fourth year. Two main reasons explain this variation. The first was related to the scope. In the first year scope was not well defined and understood by all stakeholders. Different BUs had different perceptions and some didn't understand the concept of the program. In addition the regulation was still new and its impact on the entire organization was not clear.

The second reason was related to the team maturity and capacity to execute. A new team was formed to achieve this program. B-Bank didn't have the resources to achieve such a program and it had to recruit a large number of independent consultants. The B-Bank didn't outsource this project because no firm knows enough the internal environment of the entire bank. The latter decided to manage the entire program and have a dedicated team formed of internal resources and external consultants. The newly formed team was not capable of achieving all planned activities of the first year. Resources required some time to get familiar with the new regulation and to develop a new team organization. All resources went through a learning curve where they developed new expertise as well as a new team spirit.

4.IV.D. Change Requests of the BIIA program

At the time of writing this research the BIIA program for the A-Bank accounted for one hundred and fifty six (156) change requests which originated from different elements of our conceptual model. This is summarized in Table 4.20. The latter presents the total number of change requests per element and per category of the conceptual model developed in this research.

Table 4.20: BIIA – Number of CRs per element and category

	Category	Factor	# CR / Factor	Classi-fication	# CR / Category	Classi-fication
Exogenous Multiple Influences	External Envi.	Socio-political	0	n/a	3	6
		Industry Regulation	0	n/a		
		Competition	3	10		
	Inter. Env.	Business Needs	57	1	89	1
		Diverging BU Interest	38	3		
	Time	Fixed Date	5	8	5	5
	Market	Obsoleteness	1	11	1	7
		New Standards	0	n/a		
	Stakeholders	Number of partners	31	4	28	3
		Co-opeting	5	7		
Endogenous Emergent Uncertainties	Technology	Performance	7	6	10	4
		Compatibility	4	9		
	Solution	Evaluation	24	5	70	2
		Scope misperception	50	2		

We notice that 'exogenous multiple influences from the internal environment' and 'endogenous emergent uncertainties pertaining to the solution' are respectively the two elements with the highest number of CRs. This is mainly due to the nature of the project. The new regulation has an impact on most BUs of a Bank. BUs had to bring changes to their procedures and the way they function. Changes to formulas and calculations also had to be made. In some cases this created more work and even more restrictions for a particular BU. This was not well seen or perceived by some employees.

Furthermore the solution was not straightforward. The program team had to clarify the target solution and resolve all fuzzy areas and misunderstandings. Solution was perceived differently from a BU to another which resulted in several changes throughout the implementation lifecycle.

Below is a summary of all CRs logged for the BIIA program and their impact on the project definition elements. They are grouped by category of the independent variables of our conceptual model as seen in the previous two cases.

Exogenous – Multiple Influences – External Environment

Table 4.21 presents the change requests that were caused by each of the elements of the External environment namely Socio-political, Industry Regulations and Competition. This covers the impact of the CRs on the project definition elements.

Table 4.21: BIIA – External Environment – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Socio-political	0	0	0	0	0	0
Industry Regulations	0	0	0	0	0	0
Competition	3	3	3	2	2	3
External Environment	3	3	3	2	2	3

It is important to mention at this point that the industry regulation and socio-political elements of the external environment were relatively stable. The last element of the external environment, namely, competition played some role in generating changes to the program.

Exogenous – Multiple Influences – Internal Environment

The internal environment is composed of two main elements: 1) Business Needs and 2) Diverging BU Interests. The following will present the change requests that were caused by each of these two elements and the impact that resulted on each of the five project definition elements. Below we cover these relations through a few examples taken from the BIIA program. This is summarized in Table 4.22.

Table 4.22: BIIA – Internal Environment – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Business Needs	57	50	1	8	10	49
Diverging BU Interests	38	15	1	1	5	29
Internal Environment	89	57	2	9	12	72

The Internal Environment was responsible for a large number of Change Requests for the BIIA program. This can be traced to several reasons which are listed below:

Alignment among the priorities and IT solutions and systems of all BUs and the program's objectives was an important aspect for the success of this initiative. Different BUs had different priorities and sometimes diverging interests with respect to the program. As the regulation was understood and explained to the BUs, the program scope and multiple project scopes evolved and were clarified.

Some resistance to change from BUs faced the program. The regulation brings important changes to the operations of a bank. This resulted in some employee not willing to entirely cooperate.

At this point the Bank's culture was not mature enough in managing such large program portfolios where a large number of BUs had to cooperate and coordinate their activities.

The program had to make sure to integrate all BUs and coordinate the activities in terms of multiple constraints and dependencies. In addition the program management developed a communication strategy and a change management process to make sure everybody understands the importance and objectives of the program and its impact on the Bank.

Exogenous – Multiple Influences – Time

The Time category is limited to only one factor: Time. As explained earlier a fixed timescale was determined by BCBS. The program parties took for granted the timescale and didn't relate the CRs to the time element. Table 4.23 represents the number of CRs caused by the Time factor as well as the impact on the five project elements.

Table 4.23: BIIA – Time – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Time	5	4	4	2	4	5

Banks had to respect the regulations' timeframe or else they would be penalized. Two different approaches can be adopted by banks to comply with the Basel II Accord. The first is a sophisticated approach to measure risk and meet the Accord's deadline. The other is a basic approach of measuring risk but which compels the bank to put aside a larger capital reserve[28].

Because of a fixed Time deadline, program management had to start several projects even before an exact scope was understood. Design activities had to evolve all through the implementation phase. A fast track project mode where concurrent phases run in parallel had to be adopted.

Exogenous – Multiple Influences – Market

Below is a summary of the number of change requests that were caused by the Obsoleteness and New Standard elements and the impact that resulted on each of the five project definition elements.

[28] (http://www.canadaone.com/ezine/briefs.html?StoryID=03Jul25_1)

Table 4.24: BIIA – Market – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Obsoleteness	1	1	0	0	1	1
New Standards	0	0	0	0	0	0
Market	1	1	0	0	1	1

The market category didn't generate much CRs. This is mainly due to the nature of the program which is not a purely technological initiative. No new technology (software or hardware) is introduced. The project is mainly bringing changes to the procedures and the way a Bank calculates risk. Many functional changes are required for different application and new modules have to be developed. But this is not related to technological issues. In addition 'base software' upgrades to reflect new versions were not managed within the program. They were covered in evolutionary operational projects undertaken by each BUs.

Exogenous – Multiple Influences – Stakeholders

The Stakeholders' category accounts for two main elements: 1) number of stakeholders and 2) Co-opeting stakeholders. Several stakeholders were involved in the BIIA program.

This generated a large number of CRs which had some impact on the project definition all through the implementation phase of the BIIA program. This is summarized and illustrated in Table 4.25 below:

Table 4.25: BIIA – Stakeholders – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
# of Stakeholders	29	20	4	6	8	27
Co-opeting Stakeholders	2	1	0	1	0	1
Stakeholders	31	21	4	7	8	28

Multiple system integrators and independent consultants were recruited from external firms. They were all gathered under a program structure. Most resources working on the program were dedicated and didn't have other projects in parallel. The stakeholder's element covers different BUs that were directly or indirectly impacted by the regulation as well as top management and all partners that were involved in the program.

Endogenous – Emergent Uncertainties – Technological

The technological uncertainty is constituted of two main elements: 1) Performance and 2) Compatibility. Below is a summary of the change requests that were caused by each of these two elements and the impact that resulted on each of the five project definition elements.

Table 4.26: BIIA – Technological – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Performance	7	6	0	2	2	7
Compatibility	4	2	0	0	1	3
Technological	10	7	0	2	3	9

As mentioned previously the nature of the program was not primarily technological. The program dealt with a process rather than a technology. This got reflected in the number of CRs reported in the 'Emergent Uncertainties – Technological' element. No new software or hardware technology was introduced for this program. This resulted in a relatively stable technological element.

Endogenous – Emergent Uncertainties – Solution

The Solution's emergent uncertainties are constituted of two main elements: 1) Evaluation and 2) Misinterpretation. The following will summarize the number change requests that were caused by these two elements and the impact that resulted on each of the five project definition elements. This is illustrated in Table 4.27:

Table 4.27: BIIA – Solution – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Evaluation	24	5	1	4	4	23
Misinterpretation	50	27	2	3	7	35
Solution	70	35	2	7	9	54

As explained earlier a large number of CRs were reported under the Evaluation element. Similar to previous cases, such CRs were not associated with changes to scope. They mainly affected the cost element of the project definition. It was not an easy task for partners and managers to accurately evaluate the efforts required to execute the program. The BIIA is a very large initiative and involves most BUs of the Banks. No single partner had resources that worked with all BUs. Furthermore partners were not used to managing such large programs. This had an impact on the project evaluations and estimates. There were no baselines or previous similar initiative that can be used as a comparison.

Similarly, the Misinterpretation element was also responsible for a large number of CRs. This was more correlated to changes in Scope. Because of a large number of stakeholders, partner and BUs, several misinterpretations among the players caused changes to the project definition elements. Some BUs were overloaded with other projects and didn't have enough time to understand and participate in the design phase. Because BIIA is a new regulation, some learning was required on different levels of the program for resources to be more familiar with such an initiative. A global approach to managing change and having everybody collaborate and go through the learning curve was necessary. This took some time and several presentation and charts for everybody to be up-to-date.

4.IV.E. Conclusion

This section presented a detailed analysis a third case study covering a high innovative project for financial institutions namely the Basel II Accord. The latter is the result of an international regulation that must be followed by large banks. We saw that the BIIA, at the time of writing this research, was shaped by 156 change requests that originated from exogenous and endogenous elements mentioned in the conceptual model. As in the previous two cases, these changes had an impact on all elements of the project definition. This supports our second hypothesis where we state that project definition and scope are shaped by exogenous and endogenous elements. Also, this case supports part of the third hypothesis where we see that a highly innovative project is shaped by both exogenous and endogenous elements as opposed to a medium innovative project that is mainly shaped by endogenous elements.

Finally management team adopted the same two approaches used for the CI program to deal with dynamic project definition. These two approaches are the scope management committee and a projectized team. This will be further explored in Chapter_4_VII. The following section presents the case of two projects that are flagged as medium to low innovative by the bank. This aims at expanding the second hypothesis to medium and low innovative projects and supporting the second part of the third hypothesis which state that medium to low innovative projects are mainly shaped by endogenous elements.

4.V. Intranet Infrastructure Migration and Application Revamp

This section will cover two projects that were flagged medium to low innovative by the A-Bank. The first project is the Intranet Infrastructure Migration which is similar to the IIR program mentioned previously but on a smaller scale. The second project is the Application Revamp which consists of rewriting a banking application using a new 'base software' and a new language. We will cover the CRs that were issued for both these projects and analyze their sources and impacts on the project redefinition. The aim of these two case studies is to test our hypothesis against proprietary projects that are less innovative and less strategic for a bank.

4.V.A. Intranet Infrastructure Migration

This part will consider the case of a project that is similar to the IIR program but which is of a smaller size and classified by the A-Bank as less innovative and less strategic. Such a project, if properly managed, can usually be associated with a more stable project definition and a more stable scope across its implementation lifecycle. This case illustrates that Medium to Low innovative projects are also subject to changes that impact their scope and project definition. Changes to the latter can still be mapped to the independent variables of our conceptual model.

The project studied is the Intranet Infrastructure Migration (IIM). It consists of the same technological migration as the IIR program. Similar architecture and design to the IIR program are used to achieve this project. Before the IIM started, management team introduced a validation phase where lessons learned from the IIR program were reviewed. This covered the technical and managerial feedback gathered from the IIR program team. After this validation phase, contracts were reviewed and a new project team took over the project. This led to a more stable project definition in the case of the IIM project.

Subsequently, we will present the IIM project and go through the main phases that were followed to achieve it. Then, a summary and analysis of the CRs that were reported along this project will be covered. The same sequence will be followed as in the case of IIR program. Consequently, we will present the validation phase which played a major role in reducing uncertainties and stabilizing the project definition along the entire lifecycle.

Background

The Intranet of the A-Bank hosts all web based applications that are used by internal and external employees or partners. Subsequent to the success of the IIR program, senior management decided to perform the same technological transition to the Intranet Infrastructure which was also running at full capacity. A large number of additional internal applications are expected to move and be hosted on the Intranet Infrastructure in the coming years. Therefore, A-Bank decided to migrate the intranet applications to a new state of the art technological infrastructure to support the current and future applications.

The IIM project can be compared to the IIR in the following main features which are summarized in Table 4.28:
Innovation: IMM is an innovation for the Intranet Infrastructure. The group supporting the intranet will be dealing with this type of technology for the first time. But the A-Bank has already implemented such a technology through the IIR program. Therefore if we look at the IIM as another project for the A-Bank it cannot be considered as innovative as the IIR program was. The IIM uses the same systemic infrastructure and technological architecture as the IIR program. With proper communication among BUs, technical and managerial resources can capitalize on the experience gained from colleagues who worked on the IIR program. For that reason the IIM project's degree of innovation was flagged by the A-Bank as 'Medium' as seen in Table 4.28.
Strategy: the IIM project does not have the same impact on the bank's image as the IIR program. This infrastructure is mainly hosting applications for internal users and employees or partners of the A-Bank. In addition, it has less impact on the bank's

business than does the IIR program. It mainly supports the banks operations. Therefore the IIM project has a medium strategy level.

Complexity: The IIM project deals with more BUs than the IIR. On the other hand the hosted applications are simpler and less complex. The migration is therefore less complex on the technological side but requires more internal coordination.

Size: In terms of budget, the IIM represents 10% of the total budget of the IIR program. The time required to execute the IIM project is half the time needed for the IIR program. A larger number of resources were required for the IIR. Most of the resources were dedicated to the program. In the case of the IIM, only some resources are dedicated to the project. Most resources are working on other projects simultaneously. The IIM project is categorized by the A-Bank as a medium size project.

Table 4.28: Comparison of the main features between IIR and IIM

Feature	IIR	IIM
Innovative	High	Medium
Strategic	High	Medium
Complexity	High	Medium
Size	High	Medium

The following will summarize the CRs filed for the IIM project. All CRs will be mapped to the independent variables and the project definition as was the case in the previous cases.

Change Requests of the IIM project:

A total of twenty one CRs were reported for the IIM project. This is summarized in Table 4.29 which presents the total number of change requests per element and per category of the conceptual model developed in this research.

Table 4.29 illustrates that the IIR generated fewer CRs. This usually leads to a more stable project definition and scope. The nature of the project in terms of innovation and complexity can be associated with a more stable project definition. This assumes that project management practices, communication etc. among the client, all partners and stakeholders are mature enough. Table 4.29 summarizes below the number of CRs reported for the IIM project.

Table 4.29: IIM – Number of CRs per factor and category

	Category	Factor	# CR / Factor	Classi- fication	# CR / Category	Classi- fication
Exogenous Multiple Influences	External Envi.	Socio-political	0	n/a	0	n/a
		Industry Regulation	0	n/a		
		Competition	0	n/a		
	Inter. Env.	Business Needs	0	n/a	3	3
		Diverging BU Interest	3	4		
	Time	Fixed Date	0	n/a	0	n/a
	Market	Obsoleteness	2	5	2	4
		New Standards	0	n/a		
	Stakeholders	Number of partners	0	n/a	0	n/a
		Co-opeting	0	n/a		
Endogenous Emergent Uncertainties	Technology	Performance	6	2	7	2
		Compatibility	1	6		
	Solution	Evaluation	14	1	16	1
		Scope misperception	5	3		

It is important to notice that most CRs are reported within the Endogenous Emergent Uncertainty group. Based on Table 4.29, the Solution and Technology elements rank simultaneously first and second in terms of the number of CRs caused. This will be further analyzed in the next section. Below a summary of all CRs per element of the conceptual model and their respective impacts on the project definition is presented.

Exogenous – Multiple Influences – External Environment

As seen below in Table 4.30, no change request was associated with the external environment. The reason for this is that the IIM project is a purely internal project of the A-Bank. All applications that are related to this project are only used by internal employees or partners. No client is directly affected by these applications.

Table 4.30: IIM – External environment – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Socio-political	0	0	0	0	0	0
Industry Regulations	0	0	0	0	0	0
Competition	0	0	0	0	0	0
External Environment	0	0	0	0	0	0

Socio-political and industry regulations cannot directly impact the IIR project. They can have an indirect impact through other projects. With a medium project lifecycle that spans over one year, no new and unknown socio-political or industry regulatory factors have time to mature and require implementation. Most external regulations such as the DST were already known by the time the project execution started.

The internal nature of the project made external competition irrelevant. A-Bank employees are only working with the internal applications and not comparing other banks' internal applications to choose the best internal system. For example an employee working on the loan application would not even consider using another alternative application. In this case the employee doesn't even know what other loan applications may exist.

Exogenous – Multiple Influences – Internal Environment

The internal environment had a limited number of CRs. They are mainly associated with diverging BU interests. As previously mentioned, a larger number of BUs and partners are involved in this project. This tends to generate some CRs because of diverting BU interests. This is presented in Table 4.31.

Table 4.31: IIM – Internal Environment – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Business Needs	0	0	0	0	0	0
Diverging BU Interests	3	3	0	0	3	3
Internal Environment	3	3	0	0	3	3

We notice that only three CRs were generated because of the Diverging BU Interests factor despite a much larger number of BUs. In fact the IIM had four times more BUs than the IIR program. After a closer look at the project structure, we notice that project management team used a similar Global Calendar Committee at the very beginning of the project and invited all BUs to take part in validating this calendar. All BU leaders were asked to participate and commit to the newly built calendar. The latter was updated on a weekly basis and distributed to all parties for them to review.

Exogenous – Multiple Influences – Time

No CRs were linked to Time. There was no deadline imposed on the project by senior managers. The latter asked that the project time be reduced to a minimum to save costs and cut on the expenses of running two systems simultaneously. The project duration was not to be cut in any way that would put the project at risk. Table 4.32 illustrates that project definition was not impacted by the Time factor in the IIM project.

Table 4.32: IIM – Time – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Time	0	0	0	0	0	0

Exogenous – Multiple Influences – Market

Table 4.33: IIM – Market – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Obsoleteness	2	2	0	2	2	2
New Standards	0	0	0	0	0	0
Market	2	2	0	2	2	2

Table 4.33 summarized the CRs of the Market uncertainty. Only two CRs were reported because of the Market Obsoleteness element. Obsoleteness is a common factor in any technological initiative. Sometimes it is hard to predict in advance when a new version or a major release is launched. The best way to avoid surprises is to upgrade continuously to the latest version available. Some technical resources prefer that newest versions be tested on the market first before upgrading their own systems.

Exogenous – Multiple Influences – Stakeholders

Table 4.34 shows that no CR was filed under the stakeholder element. The major partners or system integrators that were involved in the IIM project were not in a co-opetition mode. Roles and responsibilities were very clear among all partners. The major stakeholders were not competitors on the industry level. This led to a closer collaboration among all project members. The team and collaboration spirit was easier to develop and maintain among all resources.

Table 4.34: IIM – Stakeholders – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
# of Stakeholders	0	0	0	0	0	0
Co-opeting Stakeholders	0	0	0	0	0	0
Stakeholders	0	0	0	0	0	0

A given example of such a collaborative team spirit is shown when a new simple script to transfer files between two different applications had to be programmed before tests can start. The Design document didn't mention that particular script and it was not clear which partner was to work on it. This missing script was discovered by a resource who was preparing the environment for the testing phase. The resource didn't stop work and wait till somebody programmed the script, but it took the initiative to write the script and avoided a delay before the testing phase starts. Had this situation happen in a more co-opeting environment, it would have required several managers to intervene and a potential delay in some activities could have occurred before the script was programmed.

Endogenous – Emergent Uncertainties – Technological

The IIM project is mainly a technological project. Several CRs were reported in this category. We see in Table 4.35 that six CRs were related to performance and one to compatibility.

Table 4.35: IIM – Technological – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Performance	6	1	0	2	5	6
Compatibility	1	1	0	0	1	1
Technological	7	5	0	2	6	4

Such a number of CRs is relatively low for a technological project. This is mainly due to the validation phase where lessons learned from a similar project namely the IIR program were reviewed by all stakeholders. The Design documentation was also reviewed by the architects that worked on the IIR program and several adjustments were adopted before contracts with all partners were signed. This will be further explained below.

Endogenous – Emergent Uncertainties – Solution

The solution uncertainty element generated most of the CRs reported within the IIM project. This can be seen in Table 4.36 where fourteen CRs were filed for the Evaluation element and five CRs for the Misinterpretation element.

Table 4.36: IIM – Solution – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Evaluation	14	3	5	6	5	10
Misinterpretation	5	2	0	1	5	5
Solution	16	4	5	7	10	12

Senior management didn't go for the same Fixed Cost contract as in the case of the IIR project. Instead they opted for a Time and Material contract especially after having developed some expertise with a similar project. This helped save on the cost factor by assuming the project integration. For that reason we see that several CRs were related to the Uncertainty of the Solution Evaluation element. The total cost of these CR is far less than the additional cost associated with a fixed price contract. We also notice that out of fourteen 'Evaluation' related CRs, only three had an impact on Scope. On the other hand most had a Cost impact. Such additional cost is usually covered in a cost contingency.

Misinterpretation was mainly due to unclear and/or grey areas in the given Design documentation. Despite the validation phase, we notice that few CRs were still reported in the Misinterpretation category. It is almost impossible to entirely cover all aspects and details of Design documentation. The additional cost for having a higher quality Design document is far more than the cost generated by all CRs. In addition it will require much more time to be achieved and hence delay the project initiation.

Below, is presented the actions taken by senior managers and the project management team that contributed to stabilize the project definition and the project scope evolution.

Approaches used for the IIR project

The following will discuss how the management team prepared the execution of this project and some main differences with the contractual relationships with respect to the IIR program.

Validation Phase

The project team introduced a validation phase to review the architecture and design documentation based on lessons learned and experience with the IIR program. As previously mentioned, the IIR program and IIM project have similar technological features and architectures. They use the same type of servers and hardware and same software base (with some differences in versions). Senior management introduced a validation phase and asked the team of the IIR program to review and validate the architecture of the IIM project. This resulted in constructive feedback and some design changes based on the experience acquired from the IIR program.

The architectural document was reviewed and partners were asked to review their contracts. The resources that worked on the IIR program were asked to take part in this validation phase and in reviewing the contracts.

This phase contributed to launching the IIM project with less technological uncertainties. The A-Bank decided to assume the project integrator role on the technical and management levels by assigning a project manager that was involved in the IIR program. This saved on the cost of contracting the project integration role to one of the partners.

Because the IIM project was not a first on the technical level, the A-Bank was able to capitalize on previously learned lessons from a similar project. The bank was confident enough to assume the role of the project integrator.

Contractual relationship

As stated in Chapter_4_II, the IIR program has embraced fixed price contracts with the main partners. This was due to high technological uncertainties and risks that come with highly innovative projects. In the case of the IIM project, A-bank opted for a Time and Material contract type with all partners. The A-bank was able to assume more risk especially after the validation phase that was introduced before signing the contracts.

The IIM project accounted for more BUs than the IIM program and had more stakeholders but this was an internal challenge for the bank which does not require a partner's support or expertise.

Another lesson learned was to extend the architectural phase along the execution phase. A small architectural committee that partly worked on the IIR program accompanied the project and supported the project team throughout the lifecycle of the implementation phase.

Conclusion

In conclusion, the IIM project was selected for a case study to validate our second and third hypothesis against medium to low innovative projects. It is noticed that projects that have medium innovation levels and are less strategic to a client are also shaped by several CRs. The same elements found in the previous cases took responsibility when project definition or scope changed in such a project. These factors are grouped under two main categories namely: Exogenous and Endogenous. Each of these categories is divided simultaneously into five Exogenous and two Endogenous subcategories as seen in the conceptual model.

In addition we observe that few CRs are reported in the Exogenous group and that most CRs emanate from Endogenous elements. This supports the second part of our second hypothesis. Finally, it is important to take into account that such projects should have proper management and all lessons learned from previous similar projects be integrated into the project process. The next part presents another case study of a medium to low innovative project.

4.V.B. Application Revamp

Following the success of a previous application revamp, A-Bank decided to launch a revamp project for two other complementary applications. The Application Revamp project consists of rewriting and merging two applications under one solution using a new technological infrastructure and base software.

The current applications had several issues that needed to be addressed for the bank to maintain a competitive advantage. Among the issues can be noted:

It was almost impossible to trace back errors that were entered by users. The system does not keep a detailed trace of all transactions that can be easily reviewed. This made the validation and correction process very tedious.

The A-Bank needed to improve the internal control and auditing process which required several changes to the system.

- Some important functionality that can optimise the process was missing.
- Several manual activities that often generate errors and are time consuming needed be replaced by an automated process.
- Rewriting the application in a new technology would improve the performance and the information exchange with other applications.

As in the case of the IIM project, the AR project was not a first for the Bank. The AR project built on the success of a previous initiative. The A-Bank wanted to capitalize on the experience gained in the previous project and replicate the success to the AR project. Below is presented a review of the CR reported within the AR project.

A total of 25 CRs were issued for the AR project. A summary of all CRs reported under the AR project and per category of the conceptual model is presented in Table 4.37. They are classified according to the number of CRs generated by each element of the independent variables or the conceptual model.

Table 4.37: AR – Number of CRs per factor and category

	Category	Factor	# CR / Factor	Classi-fication	# CR / Category	Classi-fication
Exogenous Multiple Influences	External Envi.	Socio-political	0	n/a	0	n/a
		Industry Regulation	0	n/a		
		Competition	0	n/a		
	Inter. Env.	Business Needs	2	4	2	3
		Diverging BU Interest	0	n/a		
	Time	Fixed Date	0	n/a	0	n/a
	Market	Obsoleteness	1	5	1	4
		New Standards	0	n/a		
	Stakeholders	Number of partners	2	4	2	3
		Co-opeting	0	n/a		
Endogenous Emergent Uncertainties	Technology	Performance	8	2	10	2
		Compatibility	2	4		
	Solution	Evaluation	7	3	16	1
		Scope misperception	11	1		

In Table 4.37 we can see that the two elements that were the most responsible for generating CRs are 'Technology' and 'Solution'. They both belong to the Endogenous – 'Emergent Uncertainties category'. We also notice that a few CRs were reported in the

'Exogenous – Multiple Influences' group. Changes mainly originated from within the boundaries of the project.

A summary of the data collected for the AR project is presented below. CRs are classified in terms of the conceptual model of this research and a brief explanation follows each table.

Table 4.38: AR – External Env. – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Socio-political	0	0	0	0	0	0
Industry Regulations	0	0	0	0	0	0
Competition	0	0	0	0	0	0
External Environment	0	0	0	0	0	0

The AR project was mainly an internal project of the A-Bank. It was not shaped by multiple influences emanating from the external environment. No CR was reported from the 'External Environment'.

Table 4.39: AR – Internal Env. – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Business Needs	2	2	0	0	2	2
Diverging BU Interests	0	0	0	0	0	0
Internal Environment	2	2	0	0	2	2

The 'Internal Environment' generated two change requests which had an impact on Scope, Time and Cost. New business needs emerged as the project was unfolding. The AR project is merging two applications and adding new functionalities. This gives the new application more capabilities and flexibilities. As the project was unfolding client had new ideas and functions to add to the AR project. Such additions help the client improve its operations. Because the project was not bound by a time factor, the client had the flexibility to add new Business Needs to the project and extend the duration of the AR project. Moreover, the addition of some Business Needs to a project in an execution mode might be less expensive than starting a new project for these Business Needs. Finally, if the business needs don't require much work, they might not justify starting a new project. So the client would have to wait for more another project in order to include his new Business Needs.

In other cases, where the Time factor is important and the Business Needs are classified as 'Nice to Have' and not 'Mandatory' the client would wait until the project is over and then start a new project to include his new Business Needs.

Table 4.40: AR – Time – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Time	0	0	0	0	0	0

The AR didn't have a fixed time or deadline that should be met. The project was not linked to any regulation or to the launch of a new financial product such as a new credit card. As for any project, management required that the project be completed as early as possible in order to reduce cost but this was not linked to any business performance or regulation that should be met by a specific date. The Time facto didn't play any role in the generating CRs.

Table 4.41: AR – Market – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
Obsoleteness	1	1	0	0	1	1
New Standards	0	0	0	0	0	0
Market	1	1	0	0	1	1

The Market element had only one Change Request. This was mainly because of the project implementation lifecycle was extended. One of the Base Software was subject to obsoleteness and project team had to upgrade to an up-to-date version. The implementation lifecycle of medium to low innovative projects doesn't span over several years. This usually contributes to stable market conditions throughout the project. Table 4.41 supports this idea where we only reported one CR for the AR project.

Table 4.42: AR – Stakeholders – Number of CRs per project definition element

Multiple Influences	Number	Scope	Organ.	Quality	Time	Cost
# of Stakeholders	2	1	0	0	2	2
Co-opeting Stakeholders	0	0	0	0	0	0
Stakeholders	2	1	0	0	2	2

Two CRs were logged under the Stakeholder element. This was mainly due to a large number of stakeholders involved in the project. Such a number of CRs remains negligible compared with the number of CRs found in highly innovative project with the same number of stakeholders.

Even though some of the stakeholders were in a co-opetition mode, there was no CR under this element. On the one hand, roles and responsibilities were clearly defined and on the other hand there were no fuzzy areas that competing partners wanted to have.

Table 4.43: AR – Technological – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Performance	8	3	0	2	5	5
Compatibility	2	1	0	0	1	1
Technological	10	4	0	2	6	6

The 'Technological' element was second in terms of the number of CRs that had an impact on the project definition elements. No pilot projects were conducted for the AR. Most of the Design was done based on theoretical considerations. This lead to some performance issues during the implementation phase which required some changes to the project definition to meet intended business needs.

A Couple of CRs were also reported for the Compatibility element. The AR solution was intended to be hooked to the main infrastructure of the bank. Project team had to make sure that the AR is compatible with all other modules with which information will be exchanged.

Table 4.44: AR – Solution – Number of CRs per project definition element

Emergent Uncertainties	Number	Scope	Organ.	Quality	Time	Cost
Evaluation	7	2	1	2	5	7
Misinterpretation	11	7	1	1	7	7
Solution	16	8	2	3	10	12

The solution element generated most of the CRs reported within the AR project. This was mainly due to high level Design documentation. The latter didn't go deep enough into the analysis and clarification of the application architecture. In addition the Design documentation was not reviewed in an ecosystem where all partners were gathered. The Design document was developed by one or two architects. A project manager took over the document and initiated the implementation phase. The project manager mentioned in the interview that he would have rather had the Design document reviewed by all stakeholders before signing new contracts and starting the implementation phase. This would have reduced scope misinterpretations among multiple stakeholders and generated less impact on the project definition.

We can also note similar to the previous cases that the Evaluation element didn't have much impact on the scope.

Conclusion

Similar to the IIM case, the AR project was selected to validate the second hypothesis and the second part of the third hypothesis. We notice that medium to low innovative projects are also associated with evolving project definition and scope. The latter is also shaped by the elements mentioned in the conceptual model. As noted in the previous IIM case study, few CRs were reported in the Exogenous group while most CRs emanated from the Endogenous elements.

4.VI. Discussion and further analysis

This section summarizes and explains the conclusions reached in the above studied case. It relates our findings to the research hypothesis. In addition, it will cover a horizontal analysis of the five case studies and draw some new findings.

4.VI.A. Hypotheses revisited

Hypothesis 2 stated that project definition and scope are shaped by multiple influences exogenous to the project boundaries as well as by emergent uncertainties endogenous to the project boundaries.

Traditionally, managers measure the project success in terms of its initial scope. They compare the final project cost and the final project implementation date to the initial budgeted cost and baseline date. Most decisions are based on two elements of the project definition namely: Cost and Time. We have seen that the scope element is the most important element of a project definition and often drives the remaining elements. Changes to scope often have an impact on the remaining elements which are; organization, quality, cost and time. This means that every time scope changes, the cost and time baselines of the project should be reviewed if they are to be used for measuring project performance.

Five exogenous elements contribute to multiple influences on the project definition. These are 1) external environment, 2) internal environment, 3) time constraint, 4) market, and 5) stakeholders. Two endogenous elements contribute to emergent uncertainties that shape the project definition. These are grouped under the technological category and the solution category. It has been noticed that all these elements contribute to the shaping process in innovative and less innovative solutions. Based on the type of project seen, some elements take more responsibility and play a greater role in the shaping process. The IIR program which is mainly a technological project was highly shaped by technological elements. Whereas the BIIA program which is a regulation to be implemented across the Bank was more impacted by the internal environment because of new business needs and diverging BU interests.

Hypothesis 3 stated that highly innovative solutions are triggered by both exogenous and endogenous changes while less innovative solutions are mainly triggered by endogenous changes.

In the five proprietary innovative projects studied above we noticed that several elements exogenous and endogenous to the project boundaries shape the project definition.

Table 4.45: CRs for Highly vs Medium to Low Innovative projects

			Highly Innovative			Medium to Low Innovative	
			IIR	CI	BIIA	IIM	AR
Exogenous - Multiple Influences	External Environment						
		Socio-Political	5	0	0	0	0
		Industry Regulation	0	25	0	0	0
		Competition	4	10	3	0	0
	Internal Environment						
		Business Needs	39	44	57	0	2
		Diverging BU Interests	29	16	38	3	0
	Time Constraint						
		Fixed Date	11	2	5	0	0
	Market						
		Obsoleteness	31	0	1	2	1
		New Standards	1	24	0	0	0
	Stakeholders						
		# of partners	21	12	31	0	2
		Co-opeting partners	20	1	5	0	0
Endogenous - Emergent Uncertainties	Technology						
		Performance	51	47	7	6	8
		Compatibility	57	52	4	1	2
	Solution						
		Evaluation	22	0	24	14	7
		Misinterpretation	37	124	50	5	11

Initially it was thought that only highly innovative solutions are mainly shaped but we saw that medium to low innovative projects are also shaped by multiple elements. This is illustrated in

Table 4.45 which summarizes the change requests issued for each project in terms of the elements of the conceptual model. A difference was noticed between highly and medium to low innovative solutions. Highly innovative solutions are shaped by exogenous and endogenous elements whereas medium to low innovative solution are mainly shaped by endogenous elements.

Highly innovative solutions are usually more strategic and have a wider scope which involves several BUs and Stakeholders. They often originate from external environments such as new regulations or competition. Such highly innovative solutions tend to have a longer lifecycle. They become subject to market fluctuations such as new standards or obsoleteness of some technological solutions. In such solutions innovation is not solely limited to technology. Innovation also covers changes to processes and procedures or products and functionalities.

On the other hand medium to low innovative solutions are more confined to one BU or have a smaller scope. They usually have a shorter lifecycle. Medium innovative solutions are often a replication of a successful initiative that a Bank or a client did apply to other BUs or products. With proper management and proper knowledge transfer, most lessons learned from the implementation of highly innovative solutions can be applied to the new medium innovative project. This reduces fluctuations in the project definition and contributes to a more stable scope.

Hypothesis 1 specified that changes to the project definition and project scope occur all through the implementation phase of an innovative project. We have seen earlier that some researches took into account changes in the project definition and scope but only during initiation of the implementation phase. This led to postponing the global contract sign off. Clients used a real options approach or launched several pilot projects to gather more data before committing to the global solution. After committing to the global solution clients and researchers didn't account for scope changes and project definition variations were limited to the Time and Cost elements.

We have seen in the five cases studied above that many changes to all the five elements of the project definition arose after the project was initiated and all contracts were signed. We partially supported the above hypothesis. Here we cover the second part of the hypothesis which mentioned that changes occur all through the implementation phase.
Figure **4.6** and Figure **4.7** represent the number of CRs/month logged across the project implementation phase for the CI and BIIA programs. These figures don't cover all the program lifecycle because the implementation was not completed at the time of writing

this research. The graphs cover a large part of the implementation phase where we see that changes were logged all through this phase. Very few CRs were logged in the early stages of these two programs. The main reason is that in both cases, the project management didn't have a change management process in early stages of the project to track the variations of the project definition. After management saw that scope was evolving in many different directions and that they didn't have enough control over the project definition, a Change Management Process was implemented. The latter helped track all CRs issued by all partners. CRs were reviewed and validated by a specialized committee then submitted to management for approval. After the Change Management Process was in place, management was much more in control of the program/project definition and scope.

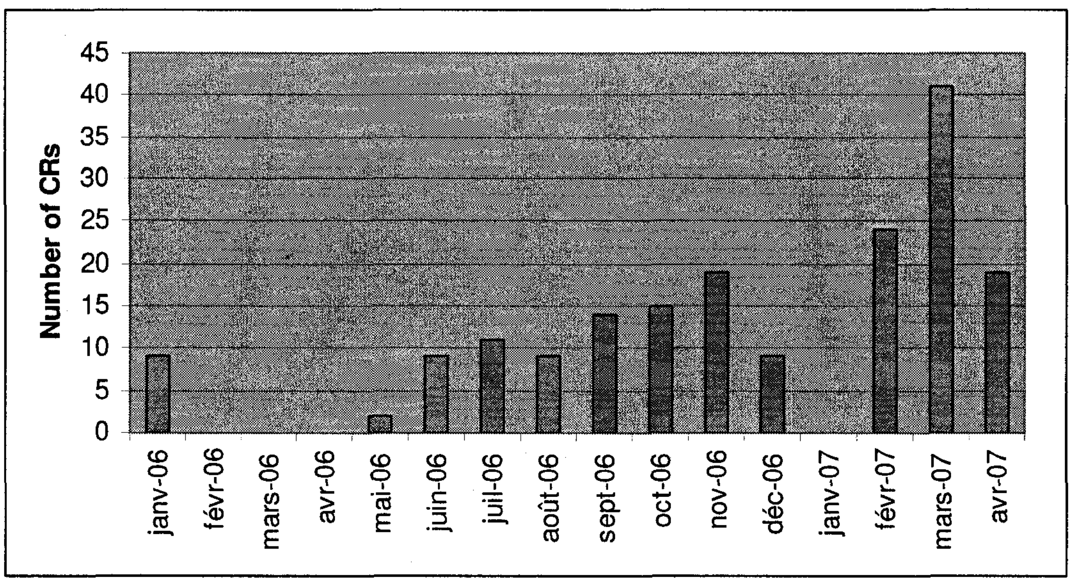

Figure 4.6: Number of CRs all through implementation of CI program.

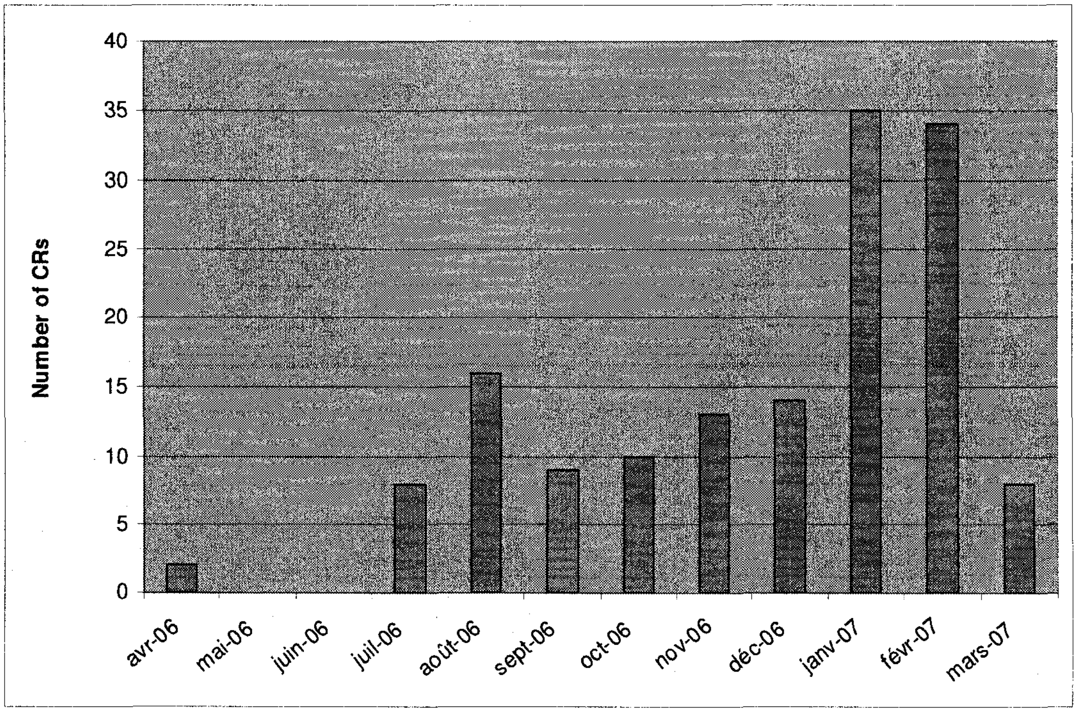

Figure 4.7: Number of CRs through implementation of BIIA.

Figure **4.6** and Figure **4.7** illustrate the number of CRs issued all through the implementation phase but don't give any indication regarding the impact of these CRs. This will be explored in the next part.

4.VI.B. Further results

This part will stress two more findings that came about during this research. The first is related to the impacts of the CRs on the project definition all through the implementation of an innovative solution. The second explores the impact of the exogenous element vs the endogenous elements on the project definition.

Impact of CR vs implementation lifecycle

In order to better understand the impact of the CRs across the implementation lifecycle of an innovative project, the IIR program which was just completed at the time of writing this research, has been selected. Documentation was not yet archived and we were able to review it in detail. It is not easy to quantify all elements of the project definition and determine the impact. The Time factor was chosen as an indicator of the degree of impact of a CR.

Figure **4.8** illustrates all CRs requests logged for the IIR program and the dollar impact of each change request. The x axis is proportional to the project implementation lifecycle. For reasons of confidentiality, the dollar amount presented in the Y axis presents a simulation of the exact amounts.

We understand from Figure **4.8** that the impact of the CRs throughout the implementation lifecycle tends to follow a logarithmic curve. This means that changes that arise at a later stage in the lifecycle tend to have less impact then changes in the initial stages. It is assumed that the project is properly managed. We see in Figure **4.8** that in the middle of the lifecycle some changes had a large impact on the cost element. But these were counterbalanced by other negative changes. They are examples of CRs on the organizational level where part of the project scope was transferred from one partner to another. The partner who lost part of his scope issued a negative change request whereas the partner who got assigned to this additional scope issued a positive CR.

Many CRs had very little impact on the cost element. They either generated changes to the time element or to the other project definition elements. Finally we can note that CRs didn't exceed 10% of the project budget. Most projects have a contingency controlled by the program manager or the client. Such contingency or buffer covers fluctuations in the program costs.

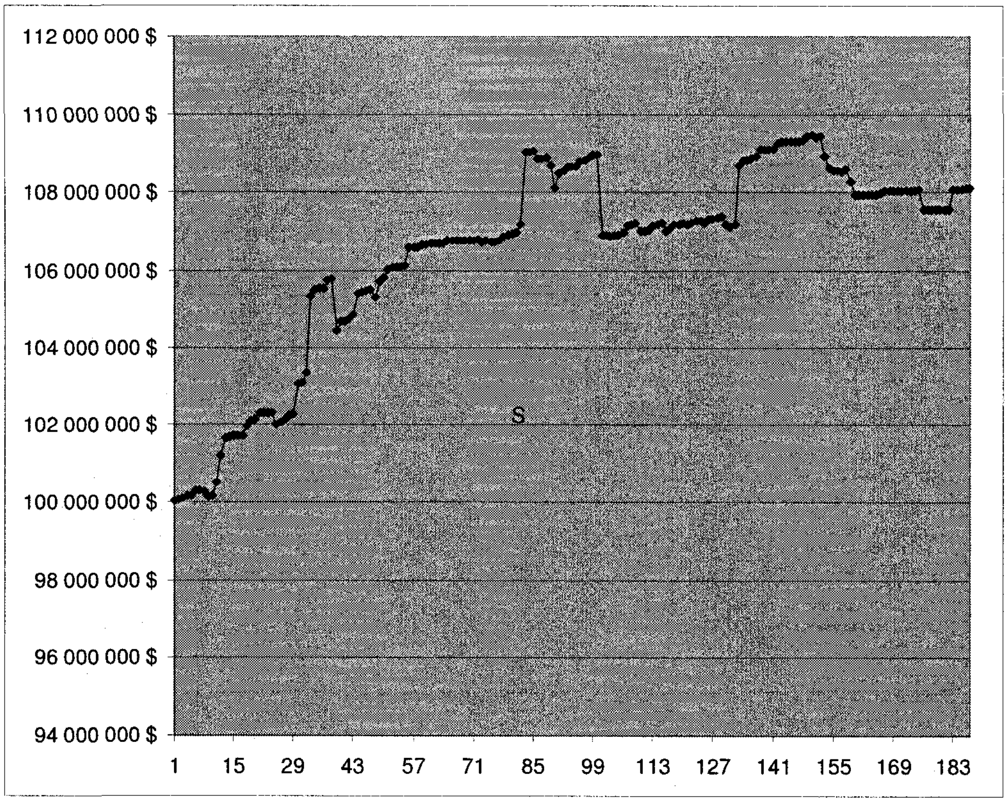

Figure 4.8: Impact of CRs of the IIR program

Impact of exogenous vs endogenous elements

In the case of the IIR program we tried to evaluate the impact of exogenous vs endogenous elements on the project. We noticed as was mentioned in Chapter_4_II, that some exogenous elements coming from the external environment had more than 25% impact on the project cost. They are limited to 5 CRs which are not illustrated in the Figure **4.8**. These 5 CRs were logged in the early stage of the program and generated a completely new program structure and scope. Because of the socio-political element the Bank had to develop a redundancy site for all its internet banking in case of any terrorist attack. This became a must after the September 11 attacks where all financial institution had to prepare for such potential threats. These CRs needed to create a new project and develop a program structure that became very large.

In the case of the Basel II Accord we can also see major changes to the global program budget that occurred at different point of the implementation lifecycle. These changes are also due to exogenous elements mainly internal environment. The program had a major impact on all BUs of a financial institution. As the regulation was studied and better understood, the program scope was getting more precise and it grew considerably to become a very large program.

On the other hand we can see that the impact of the endogenous elements is usually less important than some potential exogenous elements. We see that in most projects more changes originated from endogenous elements yet they have a lower impact than exogenous elements.

Project managers usually allocate a 15% contingency or buffer to cover fluctuation in the program/project budget. When the project is well designed, defined and managed, such a buffer usually covers most of the change requests logged all through the project implementation lifecycle. Despite this some changes emanating from the exogenous environment are beyond the boundary of the project and cannot be predicted or controlled by the project manager. Major variations to the project definition elements can then arise. Finally when a project is properly validated and managed, the impact of the endogenous CRs can be limited to the project contingency.

Table 4.46 CRs of the Evaluation element across all programs/projects

Evaluation	Number	Scope	Organ.	Quality	Time	Cost
Internet Infrast Revamp	22	3	3	1	14	18
Check Imaging	0	0	0	0	0	0
Basel II Accord	24	5	1	4	4	23
Intranet Infra Migration	14	3	5	6	5	10
Application Revamp	7	2	1	2	5	7

Table **4.46** illustrates that evaluation was often associated with a large number of CRs. This usually had little impact on the project scope and was limited to changes in the project Time and Cost. The Check Imaging program didn't trace changes to evaluation. Nevertheless 124 CRs were reported for the misinterpretation element which falls in the same endogenous group.

The next section will present different approaches used and adopted by clients and consulting firms to deal with change in the context of innovative projects. The section is the result of the fourth and fifth phases of this research. The fourth phase covers the five proprietary innovative programs/projects analyzed above. The fifth phase explores how consulting and system integration firms deal with a dynamic environment that leads to an evolving project definition.

4.VII. Firms approaches to a dynamic project definition and scope

The previous sections of this chapter presented five (5) case studies. Each case was analyzed according to the project definition elements along the entire implementation lifecycle of the solution to be implemented.

Three types of management approaches can be used when implementing a major solution: (1) rational planning, (2) adaptive planning and (3) shaping (Miller and Olleros, 2000). Rational planning considers that the future can be forecast and hence adopt long term planning approach. Adaptive planning considers that projects are unmanageable and that success is a matter of luck. Imperfect solutions are therefore considered a norm and goal alignment is never completed. (3) Shaping is the process that integrate deliberate actions and emerging responses to events.

"Successful projects are not selected but shaped [...] they then embark on shaping efforts that are most likely to unleash this value during a long front-end process" (Miller and Olleros, 2000:93). Furthermore projects tend to follow the spiral approach rather than the classical waterfall. "They are viewed as evolutionary and path dependent systems composed of episodes displaying different dynamics." (Miller and Lessard, 2007)

We have noted that project definition and scope, when subject to exogenous multiple enhancements and endogenous emergent uncertainties elements, evolve all through the project implementation lifecycle. Evolution can be measured in terms of five elements which are: Scope changes, Organizational changes, Quality changes, Time and Cost changes. Some firms developed multiple approaches to deal with these types of projects in order to adjust and/or control project definition changes and manage scope.

Such approaches can be grouped into three categories which are:

- Front end or pre-initiation that is comprised of two approaches:
- Validation Phase,
- Real Options.

Unfolding of the project or post initiation that groups two approaches:

- Scope management and control,
- Global Calendar.

Global Approaches:

- Agile Enterprise,
- Selective partnership.

In this section, I will detail these approaches and provide some examples. This is the result of data collected from the previous four phases as well as the case studies conducted in the last fifth phase.

4.VII.A. <u>Front End or Pre-Initiation</u>

Pre-Initiation is a phase or period of time that precedes the official launch (or initiation) of the entire project. The project team is not yet constituted or it is in the process of being formed. Two approaches can be adopted in this phase. The first consists of introducing a validation phase involving an ecosystem of all stakeholders where project scope, architectural design, contracts, quality processes, structures etc. are reviewed by all stakeholders. The second follows a real option's approach. It postpones the launch and commitment to the scope of the entire project and invests in some project activities leaving the option to decide later on the final project scope.

Validation Phase – Ecosystem

From an environmental perspective, an ecosystem is a "natural unit consisting of all plants, animals and micro organisms in an area functioning together with all the non living physical factors of the environment ([29])". In the case of an IT solution, the ecosystem would consist of 1) the project organization composed of all resources working directly on the project and 2) the external organization composed of resources that are directly or indirectly concerned by the project. This ecosystem also accounts for the firm's environment, such as culture, regulations, and technological infrastructure.

In its effort to strengthen the partnership with its customers, Satyam built Futurus which is a state-of-the-art Business Solutions Lab. It is the core of a virtual real-time ecosystem accessible for participation from any location in the world. This lab is an incubator that investigates emerging trends and new technologies. It is the center of an ecosystem where people from different backgrounds build top quality business solutions in a participatory environment.

Such an ecosystem plays an important role in the front end process of the solution's implementation lifecycle. This is done through an assessment of the business impact of the proposed IT solutions and Business Process Changes. Satyam stresses the importance of a validation phase before starting the development and implementation

[29] Christopherson, Roberts W. (1997). Geosystems: An introduction to physical geography, 3rd (in english), Upper Saddle River, NJ, USA: Prentice Hall Inc.

process. This phase aims at simulating with the client the future based on the designed solutions and therefore aims at testing the outcome of the project.
Some firms that focus on a particular industry reinforce their ecosystem by recruiting employees with an expertise in that particular industry. Half of Polaris employees in India are business people with a banking background. This helps Polaris better understand its client needs and hence reduce the gap of scope misinterpretation.

A firm can capitalize on previous similar projects and review lessons learned in this validation phase. An ecosystem composed of resources coming from all parties is then formed to review the project definition. This covers on the one hand the technical aspects such as the project architecture and solution's design. Technical resources who worked on such technologies can contribute to this review. On the other hand the review also covers business aspects where business analysts or senior managers from impacted BUs review the project's business objectives. Different PM working on interdependent projects can take part in this process to review multiple projects' interdependencies. Following this validation, multiple parties can adjust their contracts according to the changes and feedback of this phase. Contracts review can then be incorporated into this validation phase. This aims at reducing the divergence in scope perception and misinterpretation among all players.

Real Options approach

Some companies, in the case of large innovative and complex solutions, prefer to postpone the commitment and global investment into one particular solution. This is particularly true to solutions with high technological and market uncertainties. Therefore, firms opt for a real option's strategy where they can postpone their global commitment. They will therefore invest in several small initiatives such as pilot projects where different solution's setup and design are tested simultaneously. These provide the client with more options and time to choose the best solution according to his needs and based on the results gathered from several pilot projects or initiatives.

'Real options' thinking is important to consider for innovative solutions. When a client is determining its long term strategy and which system, solution or technology to invest in, a range of likely outcomes can be determined and the real option's approach can be very rewarding. Leading companies use real options to manage the staging, gating and scaling of cash flow decisions in the innovation process.

As mentioned in section Chapter 2_IV a project review constitutes the GO/STOP action leading to the next stage or abandoning the project. Hence innovative projects can be treated as a series of real options linked by a temporary sequence of decisions. The project process uses options of type PORO. This process helps create or build an asset of GORO type when it comes to the development of new solutions as discussed in chapter_2_V.

4.VII.B. Unfolding of the project or implementation

The unfolding phase starts after the project/program budget is approved by the client's senior management. This phase runs until the project/program closure. Contracts are signed with all parties and the project structure is formed. In this phase two approaches can be adopted to deal with a potentially evolving scope. The first approach is related to technical aspects and it consists of a Design Committee composed of senior architects or technical specialist from all parties involved in the project. This committee aims at managing the project design and scope evolution. The second approach consists of coordinating all the activities of interdependent projects to manage potential conflicts resulting from changes to the schedule of such projects. It consists of a Global Calendar that tracks the evolution of all interdependent projects along their respective lifecycle in order to avoid potential conflicts. Following we will present these two approaches providing examples.

Design Committee

After the design phase is completed, parties enter into new contractual agreements to undergo the implementation phase. A new project team is formed that aims at executing the designed architecture. Some managers incorporate in their program structure a design committee which aim at managing the scope evolution along the program lifecycle. The design committee is composed of architects or senior analysts coming from all partners. The committee usually meets on a weekly basis to review any project evolution and adjust project scope according to new data, new test results and analysis. Furthermore this committee validates new technical Change Requests issued by any partner. It will determine if the change requested by a partner is already included in the original design and scope or if it consists of a new change. The committee will validate the impact on the project from a technological perspective and provide recommendations to project management to accept or refuse the change requested by that particular party. The CR is then reviewed by management from cost, time and business perspectives and a decision to accept or reject the CR is reached accordingly.

As previously seen, innovative projects are characterized by evolving scope and design. In order to manage the evolving scope more efficiently, it becomes important to extend the Design effort across the implementation phase. Contrary to traditional project management where the design phase ends at the beginning of the implementation phase, we notice that design will overlap or stretch over the implementation phase. This is presented in figure xx which illustrates the effort required in each phase by activity type of a complete iteration. This figure represents mainly an iteration of an agile methodology which will be explained below. The main point is to have Design activities run in parallel to implementation, test and deployment effort in order to dynamically adjust to the unknowns and to uncertainties. Consequently, the project design or scope (labelled as Model in Figure 4.9) is reviewed continuously and evolves throughout all phases of the iteration.

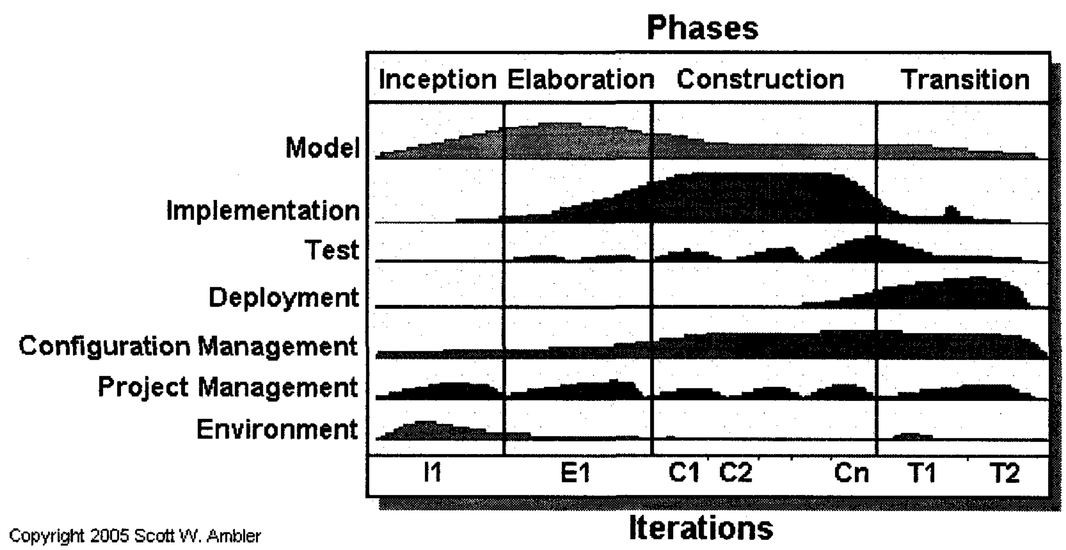

Figure 4.9: Design activities along the entire lifecycle of a solution

In the following, there will be a focus on the next approach of managing project definition along a project implementation lifecycle. It focuses on the multiple influences and multiple projects undertaken simultaneously on one global solution or common infrastructure.

Global Calendar

Multiple influences coming from different factors can result upon the solution level as well as upon a common infrastructural level. In the first case one solution can have multiple projects running in parallel and bringing changes to different modules of that particular solution. The second level covers one common infrastructure shared by multiple solutions that each has its own evolutionary project schedules. Below is presented the global calendar approach as a way and as a tool to manage multiple schedules and conflicting logics.

Three different teams can work simultaneously on one particular solution as illustrated in Figure 4.10: 1) Support or Operations, 2) Minor Evolution and 3) Major Evolution.

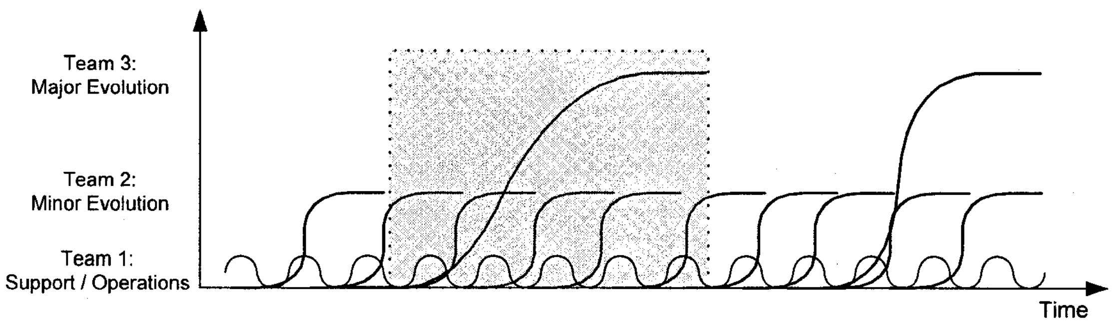

Figure 4.10: multiple teams working on one solution

The support team operates the solution on a daily basis. Its lifecycle is cyclical. Examples of such operations are automated batches that run on a daily, weekly or monthly basis. A good example is when at the end of each day a batch calculates the compounded interest of a given loan.

The second team deals with minor evolutionary projects. The latter consists of enhancements or amendments and improvements to the solution. Some examples are:

to develop a new report or fix the format of an existing one,

to add a new function to a module,

to improve a user's interface etc.

Such enhancements are managed in the context of a project lifecycle with a start and finish date. Some solutions have a predetermined number of minor evolutionary projects per year.

The third team deals with major evolutionary projects. This spans over a long period of time. Such projects are much more innovative and radical to the solution. Some

examples are 1) to rewrite and optimize several or all modules of a solution, 2) to change an entire infrastructure, 3) to change software base/technology etc.
Each of the above three teams has its own D-dates (i.e. testing phase dates, implementation dates etc.) which should not be in conflict with the other teams. Because a project is dynamic any date can change and therefore impact the other projects. Unit testing of an evolutionary project can take more time than planned and thus monopolize the Unit Testing environment for a longer period which will prevent team 3 from starting its own tests. A proper coordination on a continuous basis among all projects is important to adjust all schedules to changes. In Figure 4.10, the shaded area covers the lifecycle of a major evolutionary or innovative project. Also it can be seen that around four minor evolutionary projects are executed by another team and on the same solution in parallel. Furthermore around six or more cycles of batches and operation's cycles run at the same time. This illustrates the multiple and diverging influences among the business needs and projects affecting one particular proprietary solution.

On another level we can have multiple solutions that share a common infrastructure. Changes to any of the solutions can also have an impact on the others. This creates a more complex schedule management where several solutions coexist and share the resources of a common infrastructure. The latter could be an application or a database server hosting the solution, or an FTP server where information among different solutions and modules is exchanged etc.

In an effort to address these challenges, some firms develop an integrated global calendar an example of which is presented in Figure 4.11 below. Such a calendar groups all solutions including their corresponding evolutionary cycles into one global dashboard.

Global Calendar Date updated: 09/01/01 Next update 16/01/01

No	Applications	February				Mars					April				May				June					July			
	Week	05	12	19	26	02	09	16	23	30	07	14	21	28	04	11	18	25	02	09	16	23	30	06	13	20	27
L0	Infra Instal.		II	II	II	II	II	II																			
L1	Infra Testing					T	T	T	T	T	T	T	T														
L2	Infra Go Live													L	L												
L3	In Scope App 1			L		D	D	P	P	P	P	P	P	P	T	T	T	T	T	T	T	L			L		
L4	- App 1 evol 1					D	P	T	L																L		
L5	- App 1 evol 2										D	P	T	L													
L6	- App 1 evol 3																D	P	T	L							
L7	In Scope App 2												D	D	P	P	P	P	T	T	T	T	T	L			
L8	In Scope App 3		L										D	D	P	P	P	P	T	T	T	T	T	L			
L9	In Scope App 4						L					D	D	P	P	P	L	P	P	T	T	T	T	T	T	L	
L10	In Scope App 5		D	D	D	D	P	P	P	P	P	P	P	P	P	P	P	P	T	T	T	T		T	T	T	T
L11	In Scope App 6								D	D	D	P	P	P	P	P	P	P	T	T	T	T	T	T	T	T	L
L12	In Scope App 7				L												D	D	P	P	P	P	P	T	T	T	T
L13	In Scope App 8												L			D	D	D	P	P	P	P	P	T	T	T	T
L14	In Scope App 9																		D	P	P	P	T	T	T	T	T
L15	In Scope App 10	L					L									D	D	P	P	P	P	P	P	P	P	P	T
L16	In Scope App 11				L																L	D	D	D	P	P	P
L17	In Scope App 12				L																				D	D	P
L18	Ext App 1																										
L19	Ext App 2								L													L					
L20	Ext App 3											L															
L21	Potential																										

Legend : D: Develop P: Program T: Test L: Go Live Dates to Avoid L Go Live minor

Figure 4.11: Example of a Global Calendar

This above calendar represents the migration of an infrastructure that hosts several applications. L-0 to L17 are applications or solutions that reside on the infrastructure to be migrated and which are included in the program scope. L-18 to L-21 are applications external to the program scope but that have interdependencies with one or more modules or parts of the infrastructure. L4, L5 and L6 represent the minor evolution projects planned for the In Scope App 1.

We can also notice on L3 that the first week of every month is a period where no new applications can Go Live. This period could be associated with important monthly batches that run over long hours. A client doesn't want to impact the solution's monthly batches by allowing a Go Live during the first week of a month. Some applications such as the L7-In Scope App 2 have a long period of code freeze. This means that no changes to code are allowed during this period. In the case of L7, all March is subject to a code freeze. The letters D, P, T, L represent the solutions or applications' implementation lifecycles: Development, Programming or coding, Testing and Go Live.

The global calendar approach is very useful in the case of large integrated solutions where multiple applications share some common resources.

In the next section the third group of approaches that deal with dynamic and evolving project definition and scope as a global approach is presented.

4.VII.C. Global Approach

The third category of approaches is not limited to a phase of the project lifecycle i.e. front end or implementation. It consists of a global approach and strategy that a firm adopts. Examples are a client firm that chooses to adopt an Agile development methodology or even introduce Agility in its operations. Furthermore a client firm can choose to partner with a complementary partner and transfer part or the entire uncertainty factor and reduce the concurrent multiple influences. This is presented below.

Agile strategy

Another way to manage large innovative projects with dynamic project definition is to adopt a dynamic development strategy. An example of such a strategy is to use the Agile development methodology. Agility can also be brought to the enterprise level where a firm can adapt to a dynamic environment. This section will start by explaining and defining what is Agile Software Development. Next an explanation of the particularities and characteristics of this methodology and when it is best suited will be given. Finally an introduction of the Agility at Enterprise level will be introduced.

What is Agile Software?

"Agile software development (ASD) is a conceptual framework for undertaking software engineering projects that embraces and promotes evolutionary change throughout the entire life-cycle of the project"[30]. Highsmith and Cockburn state that "Adaptive Software Development [...] view change from a perspective that mirrors today's turbulent business and technology environment." They consider that "Agile development combines creative teamwork with an intense focus on effectiveness and maneuverability" (Highsmith and Cockburn, 2001). They explain that ASD is iterative, incremental, self-organizing and emergent.

In other words, ASD acknowledges that scope evolves across the project lifecycle and therefore changes to design and functions are to be taken into account accordingly. The scope of an IT solution is altered by many factors that cannot be controlled by the project team. Therefore ASD consists of a dynamic framework that adapts to changes in the project definition.

Mayor-Smith (2001) traces this concept back to the Egyptian civilizations where a Pharaoh ordered his engineers/architects to build a big pyramid that was to be completed before he dies. A group of physician and engineers worked hard to figure out how long

[30] http://en.wikipedia.org/wiki/Agile_software_development

the Pharaoh would live and how to build a big pyramid in this period. The Pharaoh died earlier than expected and he was buried in semi-pyramid as seen in Figure 4.12.

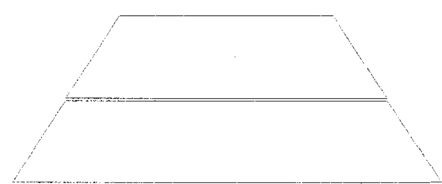

Figure 4.12: Semi-completed pyramid

The next Pharaoh wanted to avoid this situation and hence ordered his engineers to start working on a small pyramid that is was to grow as long as he lives. This is illustrated in Figure 4.13.

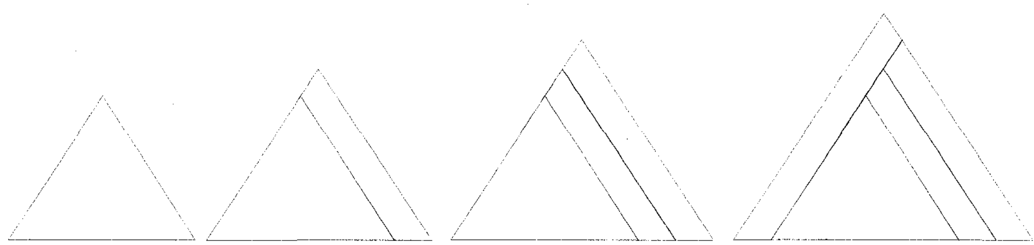

Figure 4.13: Evolutionary design of a complete pyramid

This framework ensures that the Pharaoh will end up in a complete pyramid which size may differ based on external and uncontrollable factors. Mayor-Smith's story reflects the conceptual framework used by ASD which espouses evolutionary change across the project lifecycle.

<u>**Characteristics**</u>

A gathering of seventeen of the Agile gurus in 2001 came out with the "Agile Manifesto[31]" which states the following principles for an agile methodology:

- Satisfy the customer through early and continuous delivery of valuable software.

[31] http://agilemanifesto.org/

- Welcome changing requirements, even late in the development process.
- Deliver working software frequently in a short timescale.
- Foster cooperation among business people and developers on a daily basis.
- Build projects around motivated individuals.
- Convey information to and within a development team through face-to-face conversation.
- Working software is the primary measure of progress.
- Agile processes promote sustainable development.
- Continuous attention to technical excellence and good design.
- Simplicity.
- Self organizing teams.
- Regular adjustment and adaptation.

Some of the agile methods used in software development are the following:

- Extreme Programming (XP)[32]
- SCRUM (Schwaber SCRUM)
- Agile Modeling[33]
- Adaptive Software Development (ASD)[34]
- Dynamic System Development Method (DSDM)[35]
- Lean Software Development[36]
- Agile Unified Process which is a simplified version of the Rational Unified Process (RUP)[37]
- Microsoft Solutions Framework (MSF)[38]

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[32] http://www.extremeprogramming.org/

[33] http://www.codeproject.com/gen/design/scrum.asp

[34] http://www.adaptivesd.com/

[35] http://www.dsdm.org/

[36] http://www.leansoftwareinstitute.com/art_ilsd.php

[37] http://www.ambysoft.com/unifiedprocess/agileUP.html

[38] http://www.microsoft.com/technet/solutionaccelerators/msf/default.mspx

Agility vs plan driven approaches

Agility is the other side of the coin compared to plan-driven approaches. "Where discipline ingrains and strengthens, agility releases and invents." (Boehm and Turner, 2004)

Boehm and Turner (2004) identify five critical dimensions where they differentiate between agility and plan-driven approaches as seen in Table 4.47: size, criticality, dynamism, personnel, and culture.

Table 4.47: Home ground (Boehm and Turner 2004)

Agile home Ground:	Plan-driven home ground
Low criticality	High critically
Senior developers	Junior developers
Requirements change very often	Low requirements change
Small number of developers	Large number of developers
Culture that thrives on chaos	Culture that demands order

Moreover, agile methodology can be viewed as adaptive while plan driven methodology as predictive (Boehm and Turner 2004). Adaptive techniques are inclined to adjust to a continuously changing environment. Conversely, predictive techniques have a tendency to plan the future inside out. Plan-driven methodology uses a cascade or waterfall model in the planning process whereas Agile methodology opt for an iterative or spiral model. The waterfall model is usually comprised or four main successive phases which span over the entire project lifecycle. The phases can be summarized as: Planning Execution Testing and Implementation. The project lifecycle can be split into more phases depending on each organization. The proportion of each phase with respect to the other varies from a project to another. This consists usually of one major implementation that occurs at the end of the project lifecycle. On the other hand, spiral model is composed of a succession of small cycles each comprised of the four main phases mentioned above. At the end of every small cycle a new function is implemented and an improvement to the previous functions can also occur.

When is it appropriate?

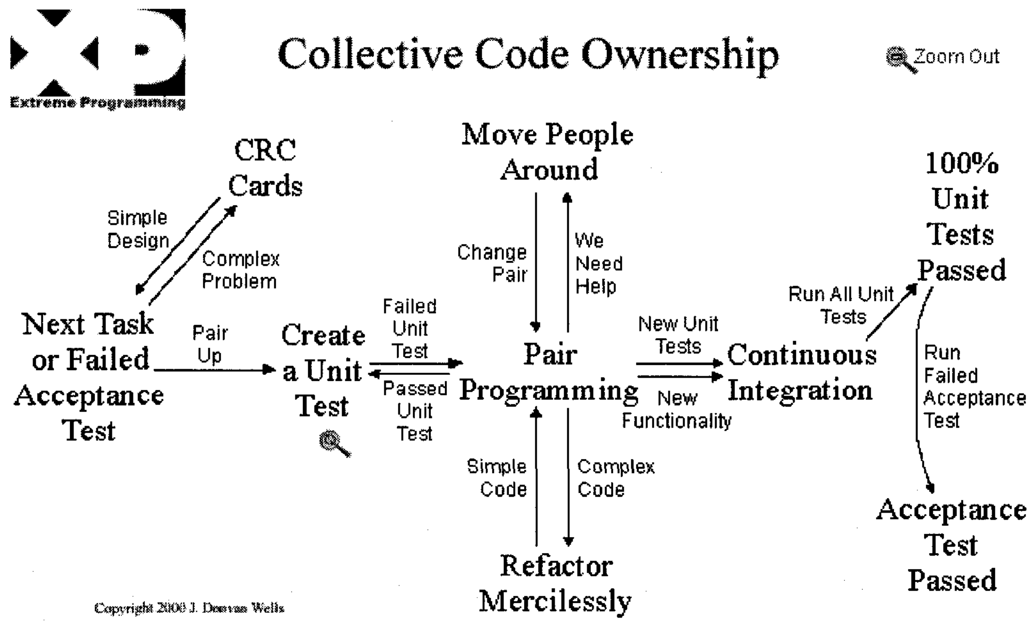
Agile modeling may not be appropriate for any project. Ambler (2002) explains that Agile Methodology is likely to work for a company based on nine factors. The first three factors he mentions state that agile modeling is likely to work when a client or developer[39]:

- Takes an agile approach to software development,
- Works iteratively and incrementally,
- Is faced with uncertain or volatile requirements.

Cohen et al (2004), stress on the size of the project as the most important factor to take into account when adopting the agile methodology. With large projects, direct interaction and communication among all stakeholders becomes more difficult (Highsmith and Cockburn, 2001).

Moreover, before starting the development process, in the case of large projects, the front end needs more investment in order to know what the optimal solution is. When the project team gathers requirements and draws initial assumptions in a fast mode, this may lead to a drift from an optimal solution.

[39] http://www.agilemodeling.com/essays/whenDoesAMWork.htm



Agile enterprise

Companies such as Infosys are bringing the Agile concept to the enterprise level. Senior managers consider that enterprise agility is a major factor for a company to renew itself in an ever-changing competitive environment. "Unless enterprise agility is designed into organizational DNA, reinventing their outmoded business models or responding to environmental challenges is a pipedream."(Mathew, 2006). Hence in a competitive environment where innovation is a key differentiator, firms should be proactive and set the pace for others to follow, rather than reactive (Jyoti Kar, 2006).

Nayan (2006) argues that the two myths behind agility, 1) only for SME and 2) lightweight and unstructured methods, are not valid. He explains that "agility is not a function of the size of an enterprise. It demands grace of an expert ballerina from a tiny mouse as well as from a giant elephant". In addition, Jyoti Kar (2006) confirms that "Agile methodologies do insist on minimal documentation" and clarifies that "the emphasis is on documenting only what is necessary and not on churning out stacks of irrelevant documents".

The argument that agility is not a function of the size is supported by Gupta and Tewari (2006) who studied three banks that worked with Infosys to implement an agility framework. They state that "banks need a robust, scalable and all-encompassing framework for imbibing 'agility' in their processes".

Selective partnership

The second global approach a firm can adopt is a partnership with one or more complementary IT firms. A client firm can choose to partner with a complementary partner and transfer part or the entire management of its technological solutions. The IT industry is evolving at a fast rate and requires from a client a great amount of investments and efforts to stay up to date with new technological trends. Some client firms prefer to invest such efforts on their core business and rely on technical IT partners and system integrators to manage part or their entire IT infrastructure and applications. Several types of partnerships can be observed on the market and they can be grouped into three categories which are: 1) Global outsourcing, 2) Partial outsourcing and 3) Application Service Providers.

Global Outsourcing

Outsourcing is the act of obtaining services from an external source (Brown and Wilson, 2005). It consists of the transfer of the operations, maintenance and evolution of a business function or business application to an external service provider or system integrator. A client and a system integrator enter into a long term contractual agreement that governs their relationship and respective roles and responsibilities. Some of the resources that work on that particular application can be transferred from the client to the system integrator's organization. This covers physical resources such as hardware, infrastructure etc. as well as human resources that operate, maintain, upgrade and develop the application and/or system.

On the other hand, outsourcing is a source of stable and recurrent revenues for system integrators. System integrators such as IBM, CGI, EDS, HP etc. rely on large and long term outsourcing agreements with major clients as a source for stable revenues. Furthermore system integrator firms can optimize their investments in a particular technology when they service several clients. Hence they take advantage of an economy of scale and achieve a faster Return On Investment (ROI).

The most common destinations for IT outsourcing are India, China, Eastern Europe, Canada (near shore outsourcing) and South America. India remains the location of choice for major IT outsourcing for several reasons. First, it has a very large English speaking population. Second India has an educated workforce or around 300 million that can be trained in information technology. Firms such as Infosys are recruiting Bachelor Arts graduates and training them in its facilities for several months on specific technologies and software programming. Infosys is planning to recruit around 20 000 graduates and train them during 2007. Third, India's government's Statement on Industrial Policy in 1991 facilitated foreign investments and technology transfer. Several Indian natives who succeeded in the United States started their own business or spin off in India.

Partial Outsourcing

Partial outsourcing means that part of the work related to an application is outsourced. This has been observed in a series of case studies conducted in India where Business Process Management (BPM) or Business Process Operations (BPO) is gaining terrain and becoming very popular.

Business Process Management (BPM) includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes (Weske et al., 2004). A senior manager at Infotech mentioned that the best combination of an academic background in India is a Software Engineering degree complemented with an MBA. This is mainly due to the popularity of the BPM which is a mix of management and information technology. BPO is used for activities and operational task that don't constitute a competitive advantage for a company.

Companies such as Infotech have dedicated teams that work for a particular client. A group of 200 employees work for the Danske Bank which is a Danish Financial Institution. They have a special schedule that adapts to the time zone of the Danske Bank in Denmark. A normal day for an employee of such a group starts around noon and ends in the late evening.

Global North American, European and Japanese firms such as IBM, HP, CGI, Oracle, SAP, Cap Gemini, Fujitsu etc. opened offices in India where they are moving part and in some cases large parts of their BPO and support operations. When calling the support line of HP an Indian employee located at the Electronics City in Bangalore will answer and provide high quality support and services. Senior managers at Infosys, Tata Consulting Services and others mentioned that 30% of the work is done onshore or at the client site and the remaining 70% is outsourced to India.

It can also be noticed that some Research and Development activities are moving to India which accounts for a highly professional and trained taskforce.

Application Service Provider (ASP) Model

An application Service Provider is an organization that hosts software applications on its own servers within its own facilities. Customers rent the use of the application and access it over the Internet or via a virtual private network (VPN) connection. The Web browser, acting as a universal client interface, has fuelled this "on-demand software" market. [40]

[40] http://www.pcmag.com/encyclopedia_term/0,2542,t=ASP&i=38037,00.asp

Some of the advantages for an organization to use an ASP are the following: 1) ASP can save money and time for a client firm. The latter doesn't have to go through the entire process of implementing a new solution and managing it. A client can be implementing a large solution and paying for the entire cost while only partially using all implemented modules. In an ASP model the client will only pay for what he uses. 2) A client won't have to wait for a complete implementation process before using a particular application or performing certain transactions. It is like having on demand transactions. Rented applications can be up and running more quickly than buying and implementing an application. This will give the client access to the best and latest software. The client won't have to worry about upgrades and costly installations. Furthermore ASP model can fill the skills shortage. 3) Finally ASP model shifts the challenge and the hassle of managing a dynamic project definition and evolving scope to the system or service provider. The client is paying for a service that is up to date and compliant with all regulations. It won't be necessary to worry about the 'how to' and all the challenge of managing and evolving IT solutions. The Royal Bank of Canada partnered with the Indian firm IGATE in an ASP model for some of its banking transactions. The bank pays IGATE a given fee per transaction performed. IGATE is responsible for maintaining, hosting and evolving the solution.

However the ASP industry comprises some challenges and risks. The industry is still young and many ASP providers ran out of business.[41] Furthermore, such a model requires a strong network solution where applications should be easily accessed through the internet with a high uptime. Finally, ASP model can apply for generic applications and not for proprietary solutions that constitute the core business and competitive advantage for a particular client.

In conclusion this section went through approaches used by different client firms to deal with change and the elements that impact the project definition throughout the entire

[41] http://dictionary.bnet.com/definition/ASP.html

lifecycle. We saw an overview of three main groups of approaches that aim at managing exogenous and endogenous groups of independent variables. Each of the above mentioned approaches can be further detailed and analyzed. This is beyond the scope of this research.

CHAPTER 5: CONCLUSION

This research is part of the global MINE program where the concept of Games of Innovation has been developed. The concept of Games of Innovation rejects the universal prescription model of innovation that applies to all firms and industries. It stipulates that there are diverse patterns by which firms innovate. This is based on different contextual variables that determine the Game in which firms play in and compete (Miller and Olleros, 2006).

This research focused on the System and Consulting Engineering services Game of innovation which is characterized by high market dynamics and strong interdependence among several actors and partners. A knowledgeable client engages in large projects such as the implementation of a large integrated system or a major technological application or infrastructure revamp. Consequently, clients engage in long term partnerships with system integrators to achieve such projects. Partnerships often extend beyond the implementation lifecycle of that particular system.

This research was conducted in five phases as explained in chapter_3. Below is a brief summary of the results and conclusions of each phase. Afterwards, a highlight of future development is also presented.

The first phase studied the different players of the SCE Game. We identified four different main players in addition to the client that partake in the implementation of an innovative solution. These players are: the strategist, the architect, the program/project manager and the operator. Each player has different characteristics and plays different and complementary roles in the entire solution lifecycle (Nehme et al 2006). This was detailed in Chapter_2_1 and summarized in Table 2.1. In addition we stressed the collaboration element which plays an important role in an ecosystem where all players are interdependent. The above four players were also classified in terms of their level of interdependence and the complexity of the work to be achieved as seen in Figure 2.3. Moreover, the first phase led us to understand that innovation in the SCE game happens through large projects where multiple partners and system integrators or consultants are contracted by one client to implement a large innovative solution.

The second phase focused on large innovative projects undertaken by major client in collaboration with multiple partners and system integrators. This led to identifying three different types of integrated systems: 1) mature systems which were already implemented at several client sites and in most industries. Such systems already developed most of their modules and their implementation process is well known and tends to follow a linear model. 2) Growing systems which are still developing new modules and expanding into new industries have a more challenging implementation process. 3) Proprietary systems which had the most challenging implementations. Such systems are unique to one client. The project team can hardly capitalize on a similar previous implementation done inside or outside the client's premise. Proprietary projects were considered the most innovative compared with mature and growing solutions.

The third phase studied five proprietary projects undertaken by large financial institutions. Throughout the interviews and analysis of Phases II and III we learned that project definition and scope evolve during the solution's lifecycle. Literature hardly addresses dynamic project definition and evolving scope. Most literature acknowledges the time and schedule evolution. This doesn't address scope evolution which often drives the remaining project elements and requires a new baseline for the time and cost elements. Some literature addressed project definition and scope evolution only in the front end of the solution's implementation phase and not throughout the latter phase. This led us to focus our research on changes that occur all through the implementation of a solution.

Consequently, our research objective was to understanding how project definition which is composed of five main elements (scope, organization, quality, cost and time) evolves throughout the implementation lifecycle of a large strategic proprietary complex innovative IT solution.

The fourth phase focused on studying more than 500 change requests logged for five proprietary programs/projects undertaken by major financial institutions. A large documentation of CRs, contracts, design documents, meeting minutes etc was collected and analyzed in addition to numerous interviews with resources that were involved in the programs/projects. All change requests were mapped to the conceptual model described in Chapter_3_IV. The model evolved throughout the mapping process. Five iterations of the mapping were required to finalize the model. Below is a summary of the main results that support the research hypothesis as well as new findings reached during this research.

Changes to the project definition and project scope occur all through the implementation lifecycle of an innovative project. As stated above most literature does not account for the evolution of all project elements all through the implementation phase. The five projects studied showed that CRs that impacted all elements of the project definition were logged all through the implementation phase. Contrary to common thoughts, they were not concentrated and limited to the early phase. CRs were logged throughout the entire implementation phase. We also noticed that CRs are part of highly innovative as well as medium to low innovative projects. Highly innovative solutions had a larger number of CRs reported than was the case in medium to low innovative projects.

Moreover we observed that project definition and scope are shaped by multiple influences exogenous to the project boundaries as well as by emergent uncertainties endogenous to the project boundaries. Projects are shaped by exogenous elements which group the external environment, internal environment, market, stakeholders and time constraint. In addition they are shaped by endogenous elements which account for technological uncertainties and solution's uncertainties. This is detailed in the conceptual model in Chapter_3_IV. The category that was most responsible for project definition changes was related to the nature of the program/project. A technological program such as the IIR program had the highest number of CRs originate from the technology group. The second group responsible for a large number of CRs was the Internal Environment. The IIR had an impact on a large number of BUs which each had several evolutionary projects running in parallel to the program. In the case of a regulatory driven program such as the BIIA we saw that Internal Environment and the Solution uncertainty groups were the most responsible for issuing CRs and impacting the program definition. The BIIA regulation had a considerable impact on most BUs and brought changes to their procedures and systems. It took BUs a considerable time to understand and buy the new regulation. As the solution was understood BUs were logging CRs to adapt and adjust to the regulation's requirements.

Finally we observed that the project definitions of the three highly innovative programs studied in this research namely IIR, BIIA and CI was shaped by both exogenous and endogenous changes. On the other hand the project definitions of both medium to low innovative projects studied in this research namely IIM and AR were mainly shaped by endogenous elements. Highly innovative solutions cover a larger scope which often involves several BUs and numerous stakeholders. Such highly innovative programs tend to have a longer lifecycle. They become subject to market fluctuations such as new standards or obsoleteness of some technological solutions. In such solutions innovation is not solely limited to one aspect such as technology. Innovation also covers changes to processes and procedures or products and functionalities. On the other hand medium to low innovative solutions are more limited to one BU or have a smaller scope. They usually have a shorter lifecycle. Medium innovative projects are often a replication of a successful initiative that a client applied to other BUs or products. With proper management and proper knowledge transfer, most lessons learned from the implementation of highly innovative solutions can be applied to the new medium innovative projects. This reduces fluctuations in the project definition and contributes to a more stable scope.

<u>Further findings</u>

The five projects analyzed in this research contributed to new findings that complemented our research objectives and hypotheses. This is summarized in what follows.

Changes with high impact on the project definition mainly originate from the exogenous multiple influences group. While Changes with medium to low impact on the project definition come from both the exogenous multiple influences group and the endogenous emergent uncertainty group. The BIIA and IIR programs support this finding. We saw that in the case of the IIR program 5 CRs coming from the external environment generated a cost impact equivalent to more than 25% of the program budget. We can also note that all remaining CRs had a combined impact of about 10% of the program budget. In the case of the BIIA program we can also see major changes to the global program budget that occurred at different points of the implementation lifecycle. These changes are also due to an exogenous element which is mainly the internal environment. This also generated a cost impact of more than 30% of the total program budget.

In the beginning of this part we stressed that CRs were logged all through the implementation phase and that they were not only limited to the initial stage. Despite this fact we observed that the impact of the CRs on the project definition tends to decline with time. This has been observed in the case of the IIR program which was completed during our research. We were able to access and analyse the data before it got archived. We observed as illustrated in Chapter_4_VI that the impact of the CRs tends to follow a logarithmic curve. This means that changes that arise at a later stage in the lifecycle tend to have less impact then changes in the initial stages. It is assumed that the project is properly managed.

The last part of this research, which is the result of the fourth and fifth phase, focused on studying the approaches used to deal with an evolving scope and project definition throughout the implementation phase of innovative projects. We identified three groups of approaches that client and consulting firms use to deal with a dynamic project definition. We observed two approaches on the Front-End which are 1) the Validation phase where all stakeholders are gathered to review the project definition and all contracts before final commitment. 2) Real Options where small pilot projects are initiated and the commitment date is postponed until more information is available. Two approaches were found in the project unfolding which are: 1) scope management and control where a group of architects, senior analysts and managers is responsible for tracking, validating and approving changes to scope, 2) global calendar to manage concurrent projects undertaken by several interdependent BUs. Finally two global approaches were also found. They are: 1) agile strategy which consists of adopting an agile methodology on the development level or even on the enterprise level and 2) selective partnership with one or multiple SI. Different partnership models can be explored as mentioned above.

Future development

All through this research we saw that innovative projects are subject to changes emanating from different elements and that impact their project definition all through the implementation phase. This generates special project dynamics where traditional management approaches such as rational planning and adaptive planning are not appropriate. Innovative projects have special dynamics and require different management approaches such as shaping to deal with a dynamic environment and evolving project definition. Shaping represents the process that integrates deliberate actions and emerging responses to events (Miller and Lessard 2007).

Based on the degree of innovation of a particular project, senior management can take several actions and decisions to ensure the best conditions in order to succeed and meet the established objectives. Several configurations of different parameters can be composed for every project depending on in its innovation degree and contextual variables. Some of the parameters that can be taken into account are the following:
Project management team: We have seen in Chapter_2_I that different types of system integrators can take part in the implementation of a solution. Some SIs are more comfortable dealing with operation or more stable conditions. Such resources best fit low innovative project and linear implementation models where applying a rigorous process leads to success. Other resources perform better in a dynamic and challenging environment. They are better fitted with high innovative projects where continuous shaping is required. Each type of resource has its own characteristics and abilities.
Project structure: we have seen that high innovative programs adopted a projectized structure where all resources were dedicated to the program. On the other hand medium innovative projects had a strong matrix project structure where resources reported to more than one project manager in addition to their functional manager. Low innovative projects can also have a weak matrix structure or be managed in an operation's mode under the functional unit.
Contract type: Different types of contracts with system integrators can be selected to deal with multiple degrees of innovative projects. We have seen that senior managers adopted a fixed cost type contract when the project was highly innovative and accounted for high uncertainties and risks. On the other hand a time and material contract type was chosen when customer was comfortable and knowledgeable enough about the new technology or solution to be implemented. Other factors such as cost are taken into account when choosing the contract type. Clients can also choose to adopt a Real Option's approach to gather more information before committing to an entire solution.

Different types of contracts can be selected with different types of partner firms working on the same solution.

Methodology type: We have seen that high innovative projects cannot solely rely on a cascade linear methodology where phases succeed without overlapping. Different methodologies can be used to deal with innovative solutions. This ranges from: 1) purely linear, 2) linear with concurrent phases or some iterati ons within each phase and 3) purely agile.

Management Approaches: We have seen in this research three approaches to deal with dynamic project definition and scope. They are 1) Validation Phase, 2) Global Calendar and 3) Change management committee. Such approaches can also be related to the innovation degree of a project

Partnership: it's important to choose the best partner to establish clear expectations as well as roles and responsibilities. Several types of partnerships and outsourcing agreements can be developed.

Other parameters are to be explored to complete this list and have a complete configuration.

Additional research can explore the most appropriate configuration of the above parameters with respect to the innovation degree as well as the exogenous/endogenous environments of a particular project. A guideline for top management can then be developed which can help them select the best configuration of the above parameters to succeed in their innovative solution.

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APPENDIX A: CONCEPT OF GAMES OF INNOVATION

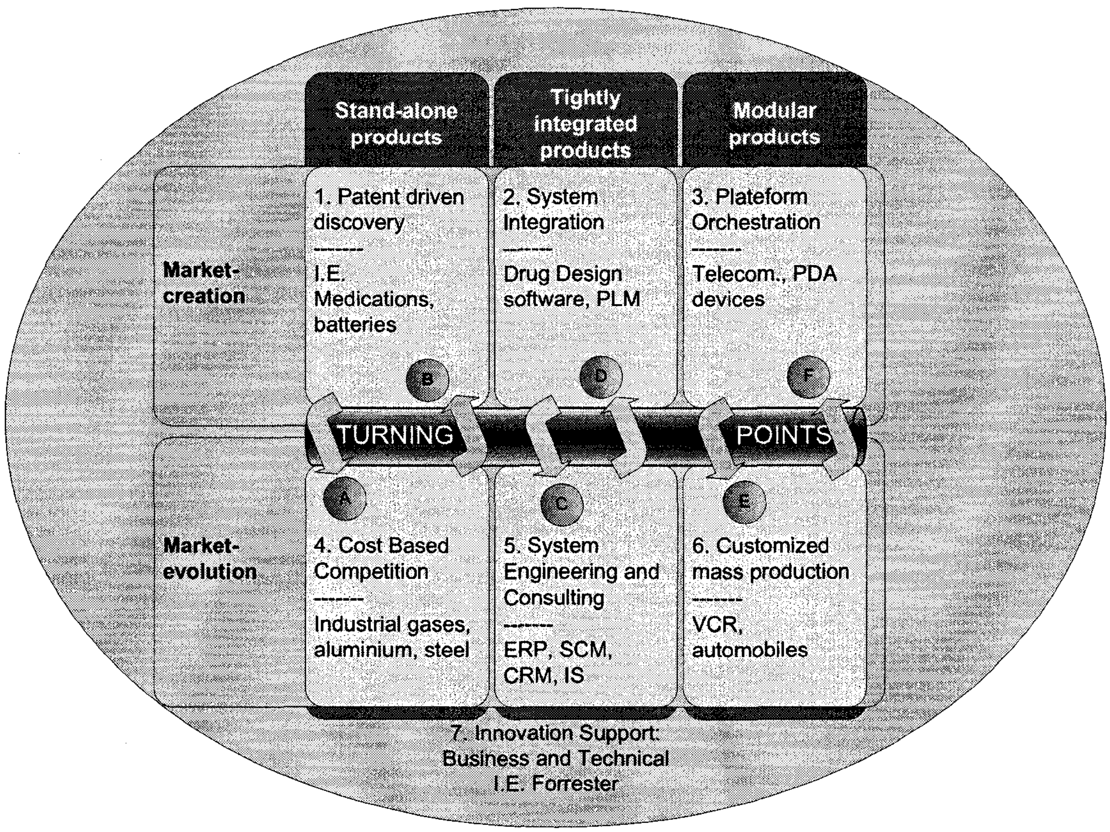

Figure A.1: Games of Innovation (Miller and Olleros 2007)

APPENDIX B: IT FOCUSED VIEW – DELONE AND MCLEAN (2003)

The revised Delone and McLean model (Delone and McLean 2003) is illustrated in the following:

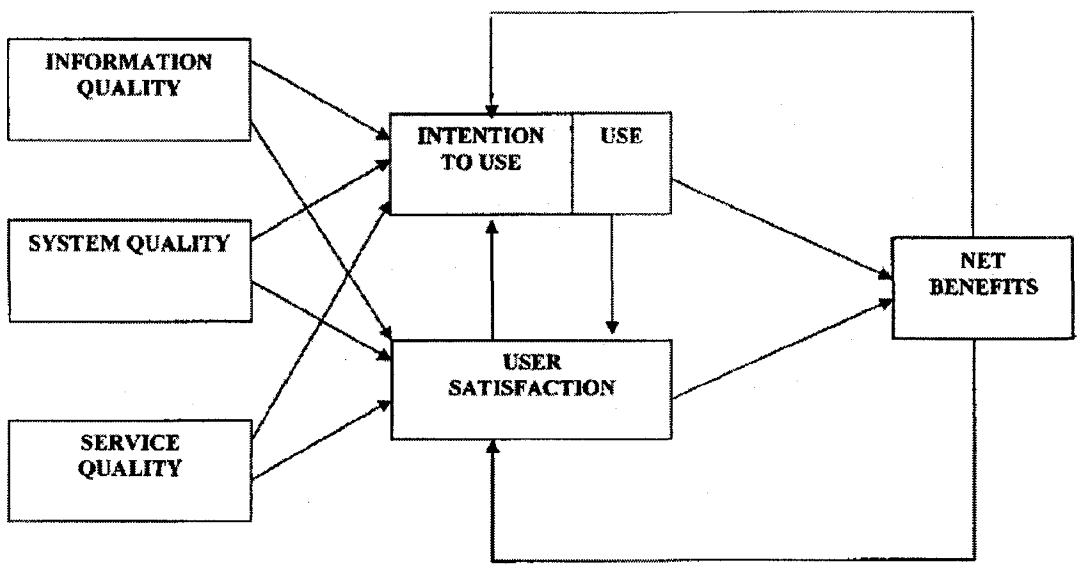

Figure B.1: IT Focused View

The E-commerce success metrics are the following:

Systems Quality: Adaptability Availabiltiy Reliability Response time Usability	Information Quality: Completeness Ease of understanding Personalization Relevance Security
Service Quality:	Use:

Assurance Empathy Responsiveness	Nature of use Navigation patterns Number of site visits Number of transactions executed
User Satisfaction: Repeat purchases Repeat visits User surveys	Net Benefits: Cost savings Expanded markets Incremental additional sales Reduced search costs Time savings

Ives et al Model

Five classes of environmental variables were delineated:
External Env.: which includes legal, social, political, cultural economic, educational, resource, and industry/trade considerations.
Organizational Env.: which s marked by the organizational goals, tasks, structure, volatility, and management philosophy/style.
User Env. : which is described by characteristics of the user, user's organization, and user's tasks
IS Dev Env: which includes the dev methods and techniques, design personnel and their characteristics, and the organizational and management of IS dev and maintenance
IS operation environment, which incorporates the resources necessary for IS operations

The classes of process variables are
Use process: which focuses on usage of the IS by the primary user and is usually measured by task accomplishment leading to an effect on productivity and decision-making quality.

Development process: which yields the IS by selecting and applying organizational resources within environmental constraints.

Operation process: Which is the physical operation of the IS and is primarily a function of the operations resource, with interfaces at the boundaries of other environment in the form of personal interaction.

APPENDIX C : OLIVER WHITE ABCD

Oliver white's ABCD: The ABCD checklist was originally introduced by The Oliver Wight Companies in 1977. A free test could be conducted on the following website http://www.bpic.co.uk/abcdlist.htm. 20 indicators are used in this test which are the following: (1) Formal S&OP process, (2) Integrated business plan, (3) One set of numbers, (4) Single database (5) Daily planning periods (6a) Stock record accuracy Actual % (6b) Bill of material accuracy Actual % (6c) Routing accuracy Actual % (7) MPS is realistic (8) Valid material plans (9) Valid capacity plans (10a) Customer service OTIF or availability Actual % (10b) Factory schedules on time Actual % (10c) Vendor Schedules on time Actual % (11a) Monthly forecast (11b) Demand management and use ATP (12) Effective NPI & change controls (13) Lead time reduction programme (14) User understanding (15) Supplier partnerships (16) Customer partnerships (17) Monitor customer service level (18) Complementary performance measures (19) Monitors competitive position (20) Continuous improvement programmes

The resulting classification can be summarized in the following classes:

Class 'D' user is typically one where either MRP is not operated or, if it is, nobody believes the MRP figures. Frequently the store room will have a manual record that anyone will refer to if they want to find out what is really in stock. Manual records and schedules are a dead give-away to poor data accuracy and a Class 'D' level of performance. Even if all the MRP II bits were in place, the lack of accurate data would render the output worthless. A Class "D" user uses the MRP/ERP package as a (very expensive) typewriter!

Class 'C' user may have a pretty good MRP system as was common in the '50s and '60s. The system will launch orders and progress chasers will expedite them according to which customers shout the loudest. They can never be better than Class 'C' because they do not attempt to manage the schedules according to the resources available. The lack of a managed master schedule and integrated capacity planning are class "C" indicators.

Class 'B' user will have capacity resource management in place via a sales and operations plan and a managed master scheduling process but the failure to properly control all the elements of ERP / MRP II will typically be shown up by the necessity to have secondary, "off system" priority information to get the 'hot' jobs through production. To be class "B" a company must have at least 95% customer service (question 10a).

Class 'A' user has a class "A" customer service (question 10a), be class "A" on 18 or more out of all the 20 questions on the checklist and will need neither shortage sheets nor progress chasers. Instead, production control and monitoring will typically be carried out using the output from the integrated planning system. The 98% or better customers service will soon become an accepted part of the company's culture. A missed shipment or even a stock error will become a major cause for concern instead of just a way of life.

APPENDIX D: SPI – CPI CALCULATIONS

SPI and CPI calculations:

The earned value technique involves developing these key values for each schedule activity, work package, or control account:

Planned value (PV): PV is the budgeted cost for the work scheduled to be completed on an activity or WBS component up to a given point in time.

Earned value (EV): EV is the budgeted amount for the work actually completed on the schedule activity or WBS component during a given time period.

Actual Cost (AC): AC is the total cost incurred in accomplishing work on the schedule activity or WBS component during a given time period. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs).

Estimate to complete (ETC) and estimate at completion (EAC) : See ETC and EAC de

The PV, EV, and AC values are used in combination to provide performance measures of whether or not work is being accomplished as planned at any given point in time. The most commonly used measures are cost variance (CV) and schedule variance (SV). The amount of variance of the CV and SV values tend to decrease as the project reaches completion due to the compensating effect of more work being accomplished. Predetermined acceptable variance values that will decrease over time as the project progresses towards completion can be established in the cost management plan.

Cost variance (CV): CV equals earned value (EV) minus actual cost (AC). The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent. Formula: CV = EV – AC.

Schedule variance (SV): SV equals earned value (EV minus planned value (PV). Shedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned. Formula: SV = EV-PV.

These two values, the CV and SV, can be converted to efficiency indicators to reflect the cost and schedule performance of any project.

Cost performance index (CPI): A CPI value less than 1.0 indicates a cost overrun of the estimates. A CPI value greater than 1.0 indicates a cost underrun of the estimates. CPI equals the ratio of the EV to the AC. The CPI is the most commonly used cost-efficiency indicator. Formula: CPI = EV/AC

Schedule performance index (SPI): The SPI is used, in addition to the schedule status, to predict the completion date and is sometimes used in conjunction with the CPI to forecast the project completion estimates. SPI equals the ratio of the EV to the PV. Formula: SPI = EV/PV.

APPENDIX E: CORPORATE CASE STUDIES

SECTION 1: ISSUES FOR DISCUSSION- SENIOR MANAGERS (TECHNICAL AND NON-TECHNICAL)

A. VALUE CREATION ISSUES AND STRATEGY

A.1 VALUE CREATION

1. How does **your firm create value for customers** through innovation activities? By what particular ways?
2. By what criteria do your **customers assess value** created for them by your firm through its products/services?
3. What are the key dimensions of **customer value** in your sector of activity? Which of them are currently emphasized. What are the main ways by which innovation creates value for the customer (i.e. most valuable kinds of innovation among developing new technologies, adding new features, cost reduction, customization etc.). How is all this changing?

A.2 CORPORATE AND BUSINESS STRATEGY

4. Please describe the **business** you are in. What are your main products, services? What is your firm's position in the value chain?
5. Please characterize your **business environment.** What major external shifts have impacted your business over the last decade or so?
6. How do you **identify and prioritize the strategic directions** you will pursue or develop through innovation (new markets, technologies, capabilities, product lines)?
7. What are the major thrusts (vectors) of your **corporate strategy**? How do innovation investment rank among them? How the importance of investment in innovation evolved in the last 10 years?

8. What are the major **strategic transformations** that your firm has experienced recently or intends to undertake?
    - Investment in innovation
    - Investment in corporate level activities
    - Investment to penetrate new markets, etc.

B. INNOVATION AND NETWORK FOR CREATION OF VALUE
(ideally draw a map of network)

9. Please describe the **network of innovative activities** that create value in your industry.
    - Draw a map of value creation activities and identify specific firms or types of firms associated with these activities.
    - Which activities in this network your firm performs itself?
    - For which ones do you rely totally or partially on other entities? Which ones do you covet? Why?
10. Who are the main **stakeholders** that influence innovative activities in your firm and your industry? (financial stakeholders, scientific community, special interests, regulators, partners, clients, suppliers, competitors). How do you interact with them?
11. What are the **other players** (competitors, complementors, innovation support) and what **roles do they play**? What is the **role of your firm** in these innovation activities?
12. As industry evolves many roles appear or disappear. What **roles in your opinion have changed over recent past and what do you see for the future?**
    - Venture capital
    - Chip design
    - Regulators
    - Sponsors etc.

13. Which factors control the **pacing (frequency) of innovation** in this industry? What are the main obstacles in your sector?

14. Who **drives innovation** in your sector?

C. ORGANIZATIONAL ISSUES

C.1 ORGANIZATIONAL STRUCTURE AND COMPETENCIES

15. What are the distinctive features of the way **innovation is organized** in your firm?
    - Organization structure and its impact on innovation (responsibilities and subordination of units and managers, configuration and sites of units and labs, decision committees etc.)
16. What are the key **organizational policies** you have developed to stimulate innovation
    - Management structure, formal and informal processes
    - Corporate policies
    - Incentives and reward systems
    - Funding
17. How do you **allocate resources** to innovation activities?
    - Level of investment
        - Innovation related expenditures (R&D, New product, etc.)
        - Partnerships with complementary players
    - Allocation between different directions and activities
        - Choice between investment in current business vs. new businesses
        - How much to invest? In what areas ?
        - Choice between internal R&D, partnership, acquisitions, etc.
        - How are these investment made: small incremental, large bets...
        - Approaches to control and evaluation
18. What are the **key capabilities** needed for innovating in your business?
    - What capabilities are needed for your current business

- What capabilities are needed due to changes in competition

19. How do you stimulate the **organizational change** required for implementing strategic directions you will develop through innovation?
    - How do you steer the external network in favor of these changes?
20. How do you **develop new technological capabilities** (proprietary technologies, platforms, core competencies) in your firm?
    - By what processes the priority directions (the technology strategy) are defined?
    - What are the preferred ways for developing new capabilities?
    - How do you renew the capabilities (ensure that old ones do not get in the way)?

C.2 KNOWLEDGE

21. Who produces the **relevant knowledge necessary** for innovation in your business (e.g. product ideas, scientific principles, technologies, operation-related knowledge)?
    - Give specific names of clients, universities, research centers, suppliers, other firms, etc. from which the main new ideas came from over the past three years.
    - Predict the next breakthroughs or innovative steps. Where are these likely to come from?
22. What key practices do you use to **obtain knowledge**, get it integrated and circulated in your organization?
    - How do you ensure that your firm is abreast of new ideas, opportunities and technologies developing outside your firm that could be relevant to your activities?
23. What techniques do you use to **stimulate the generation of ideas** for new products and technologies in your firm?
    - How do you ensure that good ideas are not suppressed? Is this a problem in your organization? What techniques do you use to protect new ideas?

D. KEY SUCCESS FACTORS

24. In your view, what are the **success factors** for innovation in your industry? Give an example of a firm that you feel has been particularly successful? Why do you say this
25. What are the factors that have **facilitated or hindered** your firm to bring innovative efforts to fruition? Please give examples (e.g. relationships with stakeholders, internal capabilities, internal misfits, blockages, other)
26. Anything to add about the **dynamics of innovation** in your industry?

- What makes for success/ failure?
- How is this changing?

SECTION 2: ISSUES FOR DISCUSSION- PROJECT MANAGERS AND TEAM LEADERS

E.1 SYSTEM OR SOLUTION CHARACTERISTICS AND RAISON D'ÊTRE

Please briefly describe the different types of projects that you encounter. (major project, infrastructure, application, support, etc)

1. Please briefly describe what the main reason to undertake this project was. Key elements of the **external / internal contexts** (market, technological, regulatory, legal, social, business etc).
2. What was the **origin** of the project? How the idea was defined, evaluated and promoted?
3. Please describe the **sequence** of key decisions, activities, milestones and **episodes** of this project (with an emphasis on knowledge production and problem solving, e.g. prototypes). Concrete dates? Budgets for every episode?
4. What major **unexpected developments and difficulties** affected the project? How did you deal with these issues? What were the factors that favored/precluded an effective response?

E.2 PROJECT CHARACTERISTICS

5. Please characterize the **organizational context** surrounding the project.
    - Position in the strategy and organization of your firm? Links with other projects?
    - What obstacles did you encounter inside your firm? What was particularly helpful?
6. Please draw the **value net** of the project: Company, Competitor, Complementor, Client, Customer and Supplier?
7. Please describe the **role** of each **stakeholder** in this project (in the value net).

- What's the role and **contribution** of each stakeholder?
- Do you have any strategic **alliances** with these stakeholders / client?

E.3 RISKS and CONTRACTUAL RELATIONSHIPS

8. Please tell us about the **risks** you face when undertaking a new IT project
   - **Technology** risk (compatibility or performance)
   - **Alliance** risk
   - **Business** risk
   - **Process** risk
9. Please tell us about the **emerging risks**

   Changes in technology

   Changes in the environmental variables
10. Please tell us about the type of **contractual** relationships you engage with your client and partners
    - What are the different type of contracts you use and why
    - What are the criteria and motivations for selecting a contract type
      - project risk (technology etc)
      - client expertise
11. Do you have a real **options** approach?
12. Does the **contract** type change with the **solutions episode**?

E.4 PROJECT EPISODES

13. Please describe the project phases and episodes?
14. What is the length of each episode
15. What is the investments (front-end vs. end, funds vs. time) required for each episode
16. What is the output of each episode
17. Are the episodes concurrent (run in parallel) or in cascade?

18. How do you deal with this?
19. What are the roles played by each partner across the episodes and why?

E.5 PROJECT SUCCESS FACTORS and INDICATORS

20. What are the main success factors
    - Environmental
    - Organizational
    - Technical
    - Procedural
    - Soft Skills
21. What are the main success indicators
    - Cost, Quality
    - System Use,
    - User Impact
    - Organizational Impact

E.6 PROJECT DESIGN

22. What are the main elements that constitute a successful project design or structrure?

Can you tell us about the project **governance**?

- Is it imposed by a client or built according to the project needs?
- How do you determine and build the governance?

23. Please tell us about the **processes** and **routines** used in a project adopted across the episodes?
    - Are they imposed by one entity or result from the new project design-alliance
    - Project Status (is it standard or depend on partners)
        - Frequency

        - Information required
    - How flexible are they
        - Authorizations process
        - Change requests and scope changes

24. Can you tell us about the **technology** and **tools** used within the project across the episodes?
    - Communication among all team members
    - Brainstorming tools
    - Planning software
    - Analysis and CPI SPI evaluation

25. Tell us about the **project team.**
    - Characteristics of resources
    - How did you choose project team?
        - Did they previously work on the same technology?
        - Did you provide training
        - Did they previously work on the same BU?
        - Do you have the option of choosing the resources?
    - How important is the learning capability of resources working on the project vs the support team?

E.7 GENERATIVE AND EVOLUTIONARY COLLABORATION

26. Please describe the innovative and collaborative process that ensures the successful implementation? (Shared organizational design)
27. Please describe how the different stakeholders collaborate together
    - Technical collaboration
    - Management collaboration
    - Technical vs management collaboration

28. What are the different type of integrators you have and why.
29. Do you have a predetermined frequency of meetings?
30. Do you have one or more rooms dedicated to the project?
31. How do you handle an incident or problem
    - Technical problem (such as software incompatibility, performance problems, security issues etc)
    - Business problem (new business need)
    - Management problem (organizational problem etc)
32. Please tell us about how you coordinate and collaborate with the support and maintenance teams?
    - What about the concurrent projects
    - Operational Transition (transferring the system from the project team to the support team)
33. How does the collaboration among different project members evolve throughout the project? Is it taken into consideration in subsequent episodes?
34. How does the alliance among the project partners evolve during an episode and across the episodes?
35. Is the alliance reflected to other projects with the same partners
36. How do you evaluate the project
    - When and freequency of evaluation
    - People involved
    - Process
37. Is this evaluation taken into account in subsequent projects?
38. Is this evaluation reflected on each partner's organization and vice versa
39. How do you learn from previous projects